THE USE OF VASCULAR PLANT INDICATOR SPECIES IN THE IDENTIFICATION OF LOCAL WILDLIFE SITES IN LINCOLNSHIRE

by

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ABSTRACT

In Great Britain, land considered to be of particular value to habitats and species is defended to varying extents by a system of protected sites, covered by national and international legislation, and by national and regional planning guidelines. A scale of relative importance is inherent in the range of designations, from non-statutory Local Wildlife Sites up to internationally recognised sites. Currently, the methods used to assign the appropriate level of protection to a site are variable and often experience-based. Methods are usually based on the Ratcliffe Criteria, originally formulated for the selection of SSSIs. These criteria are largely subjective, open to interpretation, and potentially vulnerable to challenge on scientific grounds.

Indicator species provide an alternative method for assessing the relative value of sites. Assessing the number of locally recognised vascular plant indicator within a site could be an empirical, evidence-based approach to site evaluation. Procedures for producing a list of vascular plant indicator species are discussed.

Records collected from 181 sites in Lincolnshire were analysed, with simple analyses found to produce similar results to more complex analyses, and both types of analysis producing similar results to the traditional, experienced-based approach. The use of simple lists of vascular plant indicator species therefore appears to represent a simple, evidence-based alternative approach to Local Wildlife Site assessment.

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INTRODUCTION

Site designations

Countries have a responsibility to ensure the conservation and enhancement of habitats and species in both a national and international context. The approach that Great Britain has taken to achieving this is the establishment of a system of protected sites. The national series of sites providing statutory protection for flora and fauna are the Sites of Special Scientific Interest (SSSIs). As well as underpinning other national designations (for example, National Nature Reserves), this system also provides statutory protection for sites which have been identified as important within a European context (Special Protection Areas, Special Conservation Areas and Ramsar Sites) and within an international context (for example, Wetlands of International Importance). Other, non-statutory, designations exist for sites outside this national suite (such as Local Nature Reserves and Local Wildlfe Sites), which vary in the level of protection afforded.

Local Wildlife Sites are designated by local authorities, but may be selected by organisations such as local Wildlife Trusts, or locally established selection panels.

Local Wildlife Site selection

Many of the site selection procedures currently in use are based on ten criteria which were defined by Ratcliffe (1977). These are:

1. Area (size or extent)	6. Typicalness
2. Diversity (variety or richness)	7. Recorded history
3. Naturalness	8. Position in an ecological/geographical unit
4. Rarity	9. Potential value
5. Fragility	10. Intrinsic appeal

These criteria were adapted for use in the guidelines for the selection of SSSIs (NCC 1989) and the DEFRA local sites guidance (DEFRA 2005). The SSSI guidelines and these criteria are used as a start point for many local guidelines. These criteria were designed to be used to evaluate sites as a basis for the establishment of representative areas of biological natural areas, and aimed at evaluating areas of broadly similar vegetation type against each other (Spellerberg 1992). However, the role of criteria to select local Wildlife Sites is to identify all areas of natural and semi-natural habitat that fall above a certain standard. Therefore, criteria such as typicalness and recorded history are not relevant.

Local Wildlife Site selection in Lincolnshire

Lincolnshire Wildlife Trust (LWT) has been managing a system of Sites of Nature Conservation Interest (SNCIs) since the late 1970s, with around 1800 sites currently identified. The system covers the historic county of Lincolnshire, comprising Lincolnshire County, North Lincolnshire Unitary Authority and North East Lincolnshire Unitary Authority; and the vice-counties of South Lincolnshire (VC53) and North Lincolnshire (VC54). The selection of these sites seems to have been based on

purely subjective opinions, with no set criteria. County-wide SNCI surveys were carried out in 1977 (Lincolnshire Trust for Nature Conservation Ecological Sites Survey) and 1986/8 (Lincolnshire and South Humberside Trust for Nature Conservation Coast and Country Survey), with further ad hoc survey work at other times, from which sites were notified. Many sites have not been surveyed since. Originally, sites were graded, with A*, A and B grade sites being recognised as SNCIs, and C grade sites below this standard (Crooks 1987). Sites that were yet to be surveyed were graded U. Site information was filed together in Compendium Files. Over time, this grading has become overlooked, with all sites in the Compendium Files now being regarded as SNCIs.

In 2001, the Conservation Officer at LWT produced a 52 page document “Criteria for the Selection of County Wildlife Sites in Lincolnshire” (Pike 2001). This set out to “enable the systematic identification of those sites which … make the most significant contributions to the biological diversity of the historic county of Lincolnshire”. The methodology was based on that used by English Nature for the selection of SSSIs (NCC, 1989), but set in a local context. It was recognised that some taxa and habitats were under-recorded, but it was the intention eventually to include criteria covering all taxa, and using National Vegetation Classification (NVC) habitat classification. The criteria were split into those for habitats and those for species (see Table 1).

These criteria were never field tested, nor were they adopted by LWT or any of the local authorities in Lincolnshire

Table 1 Habitats and species covered by criteria in Criteria for the Selection of County Wildlife Sites in Lincolnshire (Pike 2001)

Habitats	**Species**
Calcareous grassland	Mammals
Neutral grassland,	Birds
Woodland, parkland and scrub	Reptiles and amphibians
Heathland and acid grassland	Fish
Freshwater	Butterflies
Swamp and fen	Moths
Peatland and bogs	Odonata
Coastlands	Other insects and invertebrates
Artificial habitats	Non-marine molluscs
	Flowering plants and ferns
	[Fungi – supplement due Spring 2002]

Local Wildlife Sites are selected on a local basis, linked to Local Authorities, but they form regional and national series of non-statutory designated sites. The DEFRA review (DEFRA 2005) found that the Local Site systems currently in operation vary considerably. It concluded that the lack of a consistent approach to the selection of sites and system management made it difficult to apply national or regional policies consistently or target national funding streams.

The area covered by the Lincolnshire system is unusual in that it is covered by two different Government Regions: East Midlands, and Yorkshire and Humberside. There are four other counties in the East Midlands region that have published site selection criteria, and one in the Yorkshire and Humberside region.

Local Wildlife Site selection in other counties in the East Midlands Region

Derbyshire (Derbyshire Wildlife Trust, 2003)

Criteria revised in September 2004.

Number of pages: 131

These criteria are based on the Ratcliffe Criteria, and split into habitat and species guidelines (see table 2). The habitat guidelines use mainly NVC habitats related to UK and Local Biodiversity Action Plan (BAP) Priority habitats, together with characteristic species lists (unscored) of vascular plants and bryophytes. The species guidelines are based on national and local rarity, and assemblages. The system aims to identify "the best examples of the full range of habitat types of nature conservation value in Derbyshire", and to "include habitats or species that are national, regional or county conservation priorities due to rarity, decline or degree of threat".

Table 2 Habitats and species covered by criteria in *Derbyshire Wildlife Sites Handbook,* 2003

Habitats	**Species**
Woodland	Lichens
Wood-pasture, parkland and veteran trees	Fungi
Hedgerows and scrub	Mosses and liverworts
Grassland	Stoneworts and other algae
Lead rakes and lead spoil heaps	Flowering plants, ferns and allies
Heaths and mires	Invertebrates
Swamps, reedbeds and tall-herb fens	Amphibians
Freshwater habitats	Reptiles
Habitat mosaics	Fish
Arable plant communities	Birds
	Mammals

Leicestershire (Lott, 1999)

Guidelines published in 1999.

Number of pages: 31

These guidelines are based on habitat quality, habitat diversity, presence of Red Data Book (RDB) species, significant species assemblages, and use as a wildlife resource by the community. Guidelines are split into criteria for habitats (see table 3), RDB species, species assemblages (see table 3), and community. The habitat criteria include lists of characteristic species (vascular plants and lichens), with some score weightings, and varying with area and abundance. The breeding bird species assemblage criteria use species scores.

Table 3 Habitats and species assemblages covered by criteria in *Guidelines for the selection of Sites of Importance for Nature Conservation in Leicester, Leicestershire and Rutland,* 1999

Habitats	**Species assemblages**
Woodland	Breeding birds
Scrub	Wintering birds
Hedgerows	Amphibians
Mature trees	Lichens
Heathland	
Early successional habitats	
Rocks and built structures	
Grassland	
Wetlands	

Northamptonshire (Bedfordshire, Cambridgeshire, Northamptonshire and Peterborough Wildlife Trust 2003)

Guidelines published 2003.

Number of pages: 43

These guidelines are based on the Ratcliffe Criteria and SSSI selection guidelines, and split into habitat and species criteria (see table 4). The habitat criteria are based mainly on NVC habitats and indicator species (unscored), plus supplementary factors. The species criteria are based around nationally and locally rare species, and species assemblages.

Table 4 Habitats and species covered by criteria in *Wildlife Site Selection Guidelines, Northamptonshire*, 2003

Habitats	**Species**
Woodland, trees and scrub	Vascular plants
Neutral grassland	Non-vascular plants
Calcareous grassland	Mammals
Heathland and acid grassland	Birds
Fens, swamps and marshes	Amphibians and reptiles
Freshwater habitats	Invertebrates

Nottinghamshire (NBGRC 2004)

Criteria published in February 2004.

Number of pages: 39, plus supplementary papers

This document is similar to the Lincolnshire 2001 criteria, but with fewer habitats and taxa completed. The habitat criteria use lists of characteristic vascular plant species, without any scoring. The habitats and species with completed criteria are shown in table 5, with parklands, bogs, fens, walls/rock faces, arable, improved pasture, and conifer plantation awaiting criteria. The species criteria are based on national and local rarity, and species assemblages.

Table 5 Habitats and species covered by criteria in *SINC Selection in Nottinghamshire*, 2004

Habitats	**Species**
Woodland	Fungi
Wetland	Odonata
Neutral grassland	Lepidoptera
Marsh grassland	Birds
Heathland	Herpetofauna
Dry acid grassland	
Calcareous grassland	

Local Wildlife Site selection in other counties in the Yorkshire and Humberside Region

North Yorkshire (Shepherd 2001)

Guidelines published in May 2001

Number of pages: 128

The habitat guidelines are mainly based on NVC habitats and lists of plant indicator species (with some weighing). For each habitat, attributes are given that relate to the six criteria of: size, representativeness, diversity, rarity, naturalness, and position in an ecological unit (from the Ratcliffe Criteria). The species guidelines are based on protected, nationally and locally rare, and at risk species, and species assemblages. For both habitats and species, each guideline has the application and rationale stated,

Table 6 Habitats and species covered by criteria in *Sites of Importance for Nature Conservation in North Yorkshire. Guidelines for Site Selection*, 2001

Habitats	**Species**
Grassland	Vascular plants
Woodland, scrub and hedgerows	Non-vascular plants
Parkland, wood pasture and scattered trees	Fungi
Fens, lowland mires, springs and flushes	Mammals
Standing water habitats	Birds
Flowing water habitats	Reptiles and amphibians
Coastal habitats	Fish
Upland moorland habitats	Invertebrates
Habitats on artificial substrates	
Mixed habitat and structural mosaics	

Many of the above criteria use lists of characteristic species, however, it is rarely stated where the lists come from, how they were formulated, and by whom, or why particular species were selected or given extra weighting.

DEFRA Guidance on Local Sites

The DEFRA website (DEFRA 2003) states that: “The Local Sites Review group was set up in October 1999 following a commitment in the response to the consultation paper, the Governments Framework for Action on SSSIs, to develop ideas on locally important sites in consultation with local authorities and others. The Group comprised a broad range of representatives from Central Government, Statutory Agencies, Sectorial Interests and Voluntary Conservation Organisations, and considered the issues associated with the identification, protection and management of local wildlife sites. The Group reported in March 2000, and Ministers have agreed the broad thrust of the recommendations.” The most recent draft of the local sites systems guidance document was released for consultation in May 2005 (DEFRA 2005).

This document states that “Local Site systems should select all areas of substantive [nature conservation] value”, and that “all sites that meet the criteria should be selected”. However, it also talks about the “necessary number, area or proportion of sites representing a particular habitat, species or geological feature” and the “setting of overall representational targets for species, habitats and geological features”, which seems at odds with selecting all suitable areas.

The guidelines also require a knowledge of the “broad extent and quality of the nature conservation resource from which the sites will be selected”. This knowledge would only be available if there was up-to-date baseline data, which there is not for Lincolnshire. This baseline information would be used for site identification and “targets to be determined for adequate representation of the priority nature conservation features of the area”. Again, it is unclear how targets for representation fit with a system that aims to select all suitable sites.

Using the 2001 criteria to identify Local Wildlife Sites in Lincolnshire

Habitats

Those criteria covering calcareous grassland; neutral grassland; woodland, parkland and scrub; heathland and acid grassland; freshwater; and swamp and fen all have the same basic structure, containing species lists with index scores applied to each species which are added up to give a total score against which each criterion is based. The index score for each species is supposed to be based on county status, county range and sensitivity to habitat degradation, but these appear to be somewhat variable, with common species sometimes scoring higher than rarer species. There are also cases where all species in a genus score the same, regardless of the three bases. It also seems rather anomalous that rare species should increase the index score of a habitat when there are additional species criteria covering rare plant species.

There are also habitat criteria that are not based on the species present, for example, all semi-natural ancient woodlands as identified in the NCC Ancient Woodland Inventory, and all chalk streams or rivers on the Kesteven limestone unless extremely degraded or polluted. Although this may be a quick way of identifying important sites, all sites would still need to be surveyed in order to identify status and condition, and to provide data for long-term monitoring.

For those criteria which require a species index score, or identification of a specific habitat (for example, reedbeds), there is often the added factor of the area of the site, with smaller sites requiring a higher score, or being completely discounted (for example those smaller than 0.5 ha). This makes the assumption that smaller sites are less valuable than larger sites. For some plant and animal groups larger areas do support more species, however, this is not always the case, and studies have shown that equal numbers of species can be conserved by designating several small sites amounting to the same area as a single large site (Spellerberg 1992). Other habitats, such as ponds, show variation in conservation value that has little to do with size (Helliwell 1983). This bias could also lead to the temptation of surveyors to extend the area of interest to create an artificially larger site with a lower index score requirement.

The artificial habitats criteria include “all hedgerows that are identified as “important” for their biological interest under the Hedgerow Regulations 1996”. These are therefore already protected under the Hedgerow Regulations and should not need to be further protected under a Wildlife Sites system.

Also included under artificial habitats are “all orchards pre-dating 1939 that contain rare cultivars”. A list of such cultivars is not currently available, and would be of more interest to horticulturalists.

A criterion for arable land is also included under artificial habitats, looking for assemblages of five or more arable weeds. However, such sites would be very difficult to notify as they would be made up of areas of arable fields or margins.

Because the criteria are based on specific habitats, a decision has to be made as to which criterion to use for each site. This could be an issue where it is not obvious, for example, whether a grassland site is neutral or calcareous, or where a site consists of a number of different habitats, for example a woodland with wide grassy rides and a stream.

Species

The species criteria are mainly based on species that have some sort of status, for example, protected under the Wildlife and Countryside Act 1981, published in a national Red Data Book, or listed as endangered or vulnerable in *Nature in Lincolnshire* (Smith 1996). For those species that already have legal protection, there is no need to include specific criteria. Species identified in Red Data Books or as being important at a local level will often experience changes in status, and so sites would need to be re-assessed if this occurs. Currently, the information to identify which species are locally rare is not available. Smith’s (1996) “Nature in Lincolnshire”, and other lists produced using this publication, are recognised as being

out-of-date and somewhat inaccurate (Paul Kirby, pers. comm.). The Lincolnshire Naturalists' Union Flora Project is the most advanced species based project currently underway, and it has a red data list as an outcome. However, this will only become available in around two years time (Paul Kirby, pers. comm.)

The problem with notifying sites on the basis of species alone is what happens to the site if the species is no longer recorded there. The 2001 criteria suggest that sites should be resurveyed every five years, but do not include procedures for de-notification if a site becomes degraded or a species moves on.

Using DEFRA guidelines and/or other counties' criteria

DEFRA guidelines have not been universally accepted as the best way forward in the production of site selection criteria. In particular, comments that have been submitted to consultation drafts from nature conservation organisations, such as The Wildlife Trusts, have not always been taken on board (Rachel Hackett, pers. comm.).

There is considerable variation in the site selection guidelines produced by the other counties in the East Midlands and Yorkshire and Humberside Regions, therefore there is no commonly agreed method. Both Derbyshire and North Yorkshire have produced guidelines that are over one hundred pages long; guidelines for Leicestershire are only thirty one pages long. Numbers of habitat criteria vary from six to ten, and species criteria from four to eleven. Criteria need to be in an easily understandable format so that they can be used and accepted by planning officers

and non-specialists. Lengthy documents with many different options for site selection may be viewed as over-complicated.

Surrogate species

Where detailed information regarding the distribution and status of species and habitats is not available, conservation effort, for example in the selection of sites for protection, may be focused on a small number of “surrogate” species. There are three common types of surrogate species:

1) Flagship species. These are charismatic species that attract public interest and support.
2) Umbrella species. The protection of umbrella species also protects a range of other species co-existing in the same habitat, often because the umbrella species requires large areas of habitat.
3) Indicator species. These are sets of species which characterise a habitat community or ecosystem by:
    a. Demonstrating fidelity to a community or habitat type;
    b. Exhibiting a specific niche or a defined range of ecological tolerances.

Using vascular plants as indicator species

Studies have shown that vascular plants can be used as indicators to identify small scale sites of conservation value, i.e. those with high biodiversity, acting as a surrogate group for other plant and animal species groups (Kati *et al*. 2004; Panzer & Schwartz 1998; Pharo *et al*. 2000; Sæterdal *et al*. 2003; Sauberer *et al*. 2004). One of these studies showed that birds could also be used as a surrogate taxon (Sauberer *et al*. 2004). Two studies concluded that the use of indicator groups was less useful in identifying sites to protect rare or at risk species (Lawler *et al*. 2003; Panzer & Schwartz 1998). A review of ten ecological evaluation methods for land use planning in the Netherlands showed that most methods used data from plant species and plant communities (van der Ploeg & Vlijm 1978).

Unless all sites are going to be surveyed for all species, the use of indicator species is essential. When the 2001 criteria were written, it was expected that criteria for all groups would be included “once the expertise is available to properly survey for under-recorded groups”. Almost all taxa, except for vascular plants, are still under-recorded in Lincolnshire. Even with better recorded groups, the effort is mainly restricted to reserves and other known sites. There is no point in having criteria that require knowledge of, for example, assemblages of breeding Odonata, if there is no likelihood of this data being collected.

Habitats are also under-recorded in Lincolnshire, with no comprehensive dataset available even at Phase 1 level. Therefore criteria based on NVC or BAP Priority

habitats would also not be suitable, unless the recording effort was increased to allow for their identification.

Most of the data already held relating to sites are vascular plant records collected on site surveys, and so older information can also be used to evaluate sites and identify changes. There is much less data relating to other taxa, with collection tending to be on a more *ad hoc* basis. Many sites only have vascular plant data associated with them.

The need for a rapid site identification method

There are currently about 1800 sites designed as Sites of Nature Conservation Interest in Lincolnshire. An estimate of half a day per site has been given for a Phase 1 and botanical survey (Steel 2004), which means that it would take over seven and a half man-years to resurvey each of these sites. A review programme of five to ten years has been recommended for sites (DEFRA 2005), which means that more detailed surveying is unlikely to be possible. Using a list of indicator species means that analysis can quickly be carried out on a species list produced in the field

Sources of vascular plant indicator species

Although many site selection criteria use lists of indicator species, they do not tend to indicate how the species were chosen, or what references were used. This is essential if the lists are to be used effectively. Lists of indicator species can be found

in published studies (for example, the study of ancient woodland indicators in the Lincolnshire Limewoods (Peterken and Game 1984), and in methodologies for site survey and assessment (for example, those produced by English Nature and the Joint Nature Conservation Council (JNCC)). However, all such lists need to be viewed in the context that they were produced in, and adapted for a local area. Local Floras and Red Data Books can also be used to provide local context.

METHODS

Production of a list of vascular plant indicator species for Lincolnshire

Indicator species, both positive and negative, are used by English Nature and the JNCC for SSSI condition monitoring and common standards monitoring within specific habitats. The habitats relevant to Lincolnshire covered by SSSI condition monitoring are lowland grassland (see Appendix 1) and lowland heathland (see Appendix 2). Those covered by common standards monitoring are the coastal habitats of sand dunes, saltmarsh, and vegetated coastal shingle (see Appendix 3), lowland grassland habitats (see Appendix 4), and lowland wetland habitats (see Appendix 5). These methods are intended to be used nationally, and can therefore be refined for use at a local level, for example by only using indicators for the NVC communities likely to be found locally.

The classic study of plant indicator species was that carried out to try to identify indicators of ancient woodland (Peterken & Game 1984; Peterken 2000). This study took place in the Lincolnshire Limewoods, which makes the results extremely relevant to this investigation. Subsequent studies have been carried out in East Anglia (Rose 1999). See Appendix 6 for the indicator species lists produced.

Various other studies have been carried out to try identify species that are important within or, typical of, certain habitats, including the Environment Agency (1997) and Holmes (1989) for rivers and wetlands (see Appendix 7), and Tabor (2003) for

saltmarsh (see Appendix 8).

Because most of the sources or indicator species that are available are national or regional in context, rather than local, the addition of species typical of Lincolnshire will help to skew the results. Rather than using lists of uncommon or endangered species, such as those published by the local Wildlife Trust (Smith 1988; Smith 1996), lists of typical species were collated from habitat descriptions in the Flora (Gibbons 1975) and local Biodiversity Action Plan (Farrow & Wright 2000).

It was decided to produce a single list of indicator species that would cover all habitats and habitat mosaics, rather than separate lists for each habitat type. A single list also makes analysis quicker and easier. The sources above were used to create an initial long list, consisting of positive indicator species likely to be found in Lincolnshire. This list was then condensed via the following process:

1. For critical taxa, for example *Euphrasia*, *Callitriche*, use aggregations or genus level only.

2. Check against the BSBI vice-county census (Stace *et al*. 2003) and remove species not recorded since 1970 in either North or South Lincolnshire (VCs 53 and 54), for example *Arctostaphylos uva-ursi*, *Dryas octopetala*.

3. Remove species of doubtful origins and non-natives, according to the Flora (Gibbons 1975).

4. Remove species listed in the sources as negative indicators for any habitat, unless they are mentioned as positives in 3 or more other lists, for example *Rubus fruticosus*, *Urtica dioica*.

5. Remove rare species, such as those confirmed from one site only, for example, *Epipactis purpurata*, *Maianthemum bifolium*. Rare species are not necessarily good indicator species, and searching for them may distract from recording the full suite of indicators. Their presence can be noted as part of the site description on the notification document. Rare species were identified using data already held, the *Lincolnshire Flora* (Gibbons 1975), *Lincolnshire Red Data Report* (Smith 1988), *Nature in Lincolnshire* (Smith 1996) and national statuses (Preston et al., 2002; Wigginton 1999), trying not to exclude under-recorded species.

6. Remove species that are very common and could skew a site analysis if many were present, for example *Lemna minor*, *Potentilla anserina*.

7. Accept species appearing in 4 or more sources

8. Look at species occurring in 1-3 sources and choose to accept or reject based on factors such as:
    - whether actual species are cited in sources, or just the genus
    - the sources they appear in (for example JNCC Common Standards Monitoring and EN SSSI Condition Monitoring lists were taken as being more important than lists extracted from the Flora and BAP)

The species selection process becomes more subjective as it progresses, but this is necessary if the list is going to be of a manageable length.

Using the list

The number of species recorded provides the score for the site. Only species that are not obviously planted or introduced should be counted in the site score. In order to keep the methodology simple, sub-species of a listed species should not be counted more than once, and hybrids should be ignored.

Once sites have been scored, a threshold level can be applied in order to aid site selection.

2004 survey (Fraser 2005)

In 2004 a project was carried out by Lincolnshire Wildlife Trust (with funding from Lincolnshire County Council) to survey SNCIs in four pilot areas of Lincolnshire, in order to field test the 2001 criteria. The four pilot areas were: Bardney Limewoods, Coastal Grazing Marsh, Lincoln Edge North, and The Deepings. Originally, 158 sites were targeted for survey; 128 of these sites were actually visited, with surveys carried out on 125 sites. Eleven additional sites were visited. A vascular plant species list was produced for each site, with *ad hoc* fauna records.

Additional sites

Although the 2004 survey only covered SNCIs, there are also twenty-six sites designated as SSSIs within the pilot areas (including eight Lincolnshire Wildlife Trust Reserves), and one other LWT Reserve. Vascular plant survey information was available for twenty-five of these sites, and therefore the most up-to-date information for these sites was used in the analysis, so that as wide a range of sites as possible was covered.

Thirty SNCIs were not resurveyed, due to lack of permission or failure to identify landowner. Vascular plant survey information was available for twenty of these sites, and therefore the most up-to-date information for these sites was used in the analysis.

Records from a total of 181 sites were used in the analysis.

Each site was evaluated using both the 2001 criteria and the new species list. In order to compare the results, a single score had to be assigned to each site under the 2001 criteria and the new species list. For the new species list, this was simply the number of listed species present. Where habitats were compared separately, the score from the 2001 criteria was used. Where the 2001 criteria were being compared against the new species list in a mixed ranking, with habitat not taken into account, because the different habitats required different scores the results had to be transformed to allow for comparison. The was achieved by dividing the actual score by the threshold score required; therefore a site passing the criteria would have a

transformed score or more than one, and a site failing would score less than one. The area weighting also had to be ignored, as this gives different score thresholds.

In the report from the 2004 resurvey project (Fraser 2004), sites were listed with their original grades and with an indication of whether the surveyor considered the site to have improved, declined, or stayed the same. This information was used to produce amended grades for sites, with those that had improved going up one grade, for example B to A, those that had declined down one grade, and those that had stayed the same keeping their original grade. New sites and those with an original U grade (previously unsurveyed) were excluded from this process. This allowed for any change in site quality to be identified that might affect the analysis between the old grades and new rankings.

Comparison of the 2001 criteria with the new indicator species list

As each site was awarded a score using the new indicator species list, the old criteria (with and without scoring, and within different habitats), the old scores, and the amended scores, the sites could be ranked in order of these scores, under each system. Therefore, the different systems could be compared using the different rankings allocated to each site.

Scoring v not scoring

Comparison using the 2001 species lists with the scoring as written with the same species lists without scoring, for the three main habitats surveyed: neutral grassland;

ponds and lakes; and woodland. There were not enough sites surveyed from other habitats with criteria for rankings to be meaningful.

2001 criteria v new species list

Comparison of the rankings produced using the 2001 criteria with those produced using the new species list, for all sites (2001 criteria scores transformed), and within the three main habitats surveyed.

2001 criteria & new species list v old grades

Comparison of the rankings produced using the 2001 criteria, and the new species list, with the original grades awarded to the sites, for all sites (2001 criteria scores transformed), and within the three main habitats surveyed. This comparison does not include new sites or those with a U grade (previously unsurveyed).

Old grades v amended grades

Comparison of the rankings produced using the original grades awarded to the sites with the amended grades extracted from the 2001 report. This does not include the SSSI sites as their gradings have not changed.

2001 criteria & new species list v amended grades

Comparison of the rankings produced using the 2001 criteria, and the new species list, with the amended grades extracted from the 2001 report, for all sites (2001 criteria scores transformed), and within the three main habitats surveyed.

Pairs of rankings were compared using Spearman's Rank Correlation:

$$r_s = 1 - \frac{6(\Sigma d^2)}{n(n^2 - 1)}$$

where r_s = Spearman's Rank Correlation Coefficient
d = difference between each pair of rankings
n = number of pairs

For all the comparisons, the null hypothesis is that there is no correlation between the rankings produced using the various methods. The closer the r_s value is to one, the closer the correlation.

RESULTS AND ANALYSIS

Lincolnshire vascular plant indicator species list

The initial long list produced contained 692 species, which was then reduced to a final species list containing 336 species.

This list of plant indicator species contains species that have been identified by a variety of sources as being both indicators of “good” habitat and typical of Lincolnshire. Therefore the presence of a number of these species within a particular site will give an indication of its value, and therefore its suitability for selection as a Local Wildlife Site.

Table 7 List of Lincolnshire vascular plant indicator species

Acer campestre	*Atriplex laciniata*	*Cardamine amara*
Aceras anthropophorum	*Atriplex littoralis*	*Cardamine pratensis*
Achillea ptarmica	*Atriplex portulacoides*	*Carex acuta*
Adoxa moschatellina	*Atriplex prostrata*	*Carex acutiformis*
Agrimonia eupatoria	*Berula erecta*	*Carex arenaria*
Agrostis canina	*Beta vulgaris* ssp. *maritima*	*Carex distans*
Aira praecox	*Bidens cernua*	*Carex disticha*
Ajuga reptans	*Bidens tripartita*	*Carex elata*
Alchemilla vulgaris agg.	*Blechnum spicant*	*Carex ericetorum*
Alisma plantago-aquatica	*Bolboschoenus maritimus*	*Carex echinata*
Allium ursinum	*Brachypodium pinnatum*	*Carex extensa*
Althaea officinalis	*Bromopsis erecta*	*Carex hostiana*
Ammophila arenaria	*Bromopsis ramose*	*Carex laevigata*
Anacamptis pyramidalis	*Butomus umbellatus*	*Carex nigra*
Anagallis tenella	*Cakile maritima*	*Carex otrubae*
Anemone nemorosa	*Calamagrostis canescens*	*Carex pallescens*
Angelica sylvestris	*Calamagrostis epigejos*	*Carex panicea*
Anthyllis vulneraria	*Callitriche* sp.	*Carex paniculata*
Aquilegia vulgaris	*Calluna vulgaris*	*Carex pendula*
Armeria maritima	*Caltha palustris*	*Carex pilulifera*
Asperula cynanchica	*Campanula glomerata*	*Carex pseudocyperus*
Aster tripolium	*Campanula latifolia*	*Carex pulicaris*
Astragalus danicus	*Campanula rotundifolia*	*Carex remota*
Atriplex glabriuscula	*Campanula trachelium*	*Carex riparia*

Carex rostrata
Carex strigosa
Carex sylvatica
Carex vesicaria
Carex viridula
Carlina vulgaris
Centaurea nigra
Centaurea scabiosa
Centaurium erythraea
Ceratocapnos claviculata
Ceratophyllum demersum
Chrysosplenium alternifolium
C. oppositifolium
Cirsium acaule
Cirsium dissectum
Cladium mariscus
Clinopodium acinos
Clinopodium vulgare
Conopodium majus
Convallaria majalis
Cornus sanguinea
Crataegus laevigata
Dactylorhiza fuchsii
Dactylorhiza incarnata
Dactylorhiza maculata
Dactylorhiza praetermissa
Danthonia decumbens
Daphne laureola
Deschampsia flexuosa
Dipsacus pilosus
Drosera intermedia
Drosera rotundifolia
Dryopteris affinis
Dryopteris carthusiana
Eleocharis acicularis
Eleocharis multicaulis
Eleocharis palustris
Eleocharis uniglumis
Elymus caninus
Elytrigia atherica
Elytrigia juncea
Epilobium palustre
Epipactis helleborine
Epipactis palustris
Equisetum fluviatile
Equisetum palustre
Equisetum telmateia
Erica cinerea
Erica tetralix
Erigeron acer
Eriophorum angustifolium
Erodium cicutarium
Euonymus europaeus
Eupatorium cannabinum
Euphorbia amygaloides
Euphrasia officinalis agg.
Festuca gigantea
Festuca ovina
Filago minima
Filipendula vulgaris
Fragaria vesca
Frangula alnus
Gagea lutea
Galium odoratum
Galium palustre
Galium saxatile
Galium uliginosum
Galium verum
Genista anglica
Genista tinctoria
Gentianella amarella
Gentianella anglica
Geranium sanguineum
Geum rivale
Glaux maritima
Gnaphalium sylvaticum
Helianthemum nummularium
Hippocrepis comosa
Hippophae rhamnoides
Hippuris vulgaris
Honckenya peploides
Hottonia palustris
Hyacinthoides non-scripta
Hydrocharis morsus-ranae
Hydrocotyle vulgaris
Hypericum hirsutum
Hypericum humifusum
Hypericum perforatum
Hypericum pulchrum
Hypericum tetrapterum
Hypochaeris radicata
Iris pseudacorus
Juncus acutiflorus
Juncus articulatus
Juncus bulbosus
Juncus gerardii
Juncus maritimus
Juncus subnodulosus
Kickxia elatine
Kickxia spuria
Knautia arvensis
Lamiastrum galeobdolon
Lathraea squamaria
Lathyrus linifolius
Lathyrus pratensis
Leontodon autumnalis
Leontodon hispidus
Leontodon saxatilis
Leucanthemum vulgare
Leymus arenarius
Limonium vulgare
Linum catharticum
Listera ovata
Littorella uniflora
Lotus corniculatus
Lotus pedunculatus
Luzula pilosa
Luzula sylvatica
Lychnis flos-cuculi
Lycopus europaeus
Lysimachia nemorum
Lysimachia nummularia
Lysimachia vulgaris
Lythrum salicaria
Melampyrum pratense
Melica uniflora
Mentha aquatica
Menyanthes trifoliata
Mercurialis perennis
Milium effusum
Moehringia trinervia
Molinia caerulea
Montia fontana
Myosotis laxa
Myosotis scorpioides
Myosotis sylvatica
Myrica gale
Myriophyllum alterniflorum
Myriophyllum spicatum
Myriophyllum verticillatum
Nardus stricta
Narthecium ossifragum
Neottia nidus-avis
Nuphar lutea
Oenanthe lachenalii
Ononis repens
Ophioglossum vulgatum
Ophrys apifera
Orchis mascula
Orchis morio
Oreopteris limbosperma
Origanum vulgare
Ornithopus perpusillus
Oxalis acetosella
Paris quadrifolia
Pedicularis sylvatica
Persicaria amphibia
Phalaris arundinacea
Phleum arenarium
Phragmites australis
Pilosella officinarum
Pilularia globulifera
Pimpinella major
Pimpinella saxifraga
Pinguicula vulgaris
Plantago coronopus
Plantago maritima
Plantago media
Platanthera chlorantha
Poa nemoralis
Polygala serpyllifolia
Polygala vulgaris
Polypodium vulgare
Polystichum aculeatum

Polystichum setiferum
Populus tremula
Potamogeton berchtoldii
Potamogeton compressus
Potamogeton crispus
Potamogeton lucens
Potamogeton natans
Potamogeton perfoliatus
Potamogeton polygonifolius
Potamogeton pusillus
Potentilla erecta
Potentilla palustris
Potentilla sterilis
Primula veris
Primula vulgaris
Puccinella maritima
Quercus petraea
Ranunculus aquatilis
Ranunculus arvensis
Ranunculus auricomus
Ranunculus baudotii
Ranunculus flammula
Ranunculus fluitans
Ranunculus lingua
Rhinanthus minor
Rorippa amphibia
R. nasturtium-aquaticum
Rumex acetosella
Rumex hydrolapathum
Sagittaria sagittifolia
Salicornia sp.
Salix repens
Sanguisorba minor
Sanguisorba officinalis
Sanicula europaea
Scabiosa columbaria
Schoenoplectus lacustris
S. tabernaemontani
Schoenus nigricans
Scrophularia nodosa
Sedum acre
Seriphidium maritimum
Serratula tinctoria
Silaum silaus
Silene uniflora
Sium latifolium
Solanum dulcamara
Sorbus aucuparia
Sorbus torminalis
Sparganium erectum
Spartina anglica
Spergularia marina
Spergularia media
Stachys officinalis
Stachys palustris
Stellaria holostea
Stellaria neglecta
Stellaria uliginosa
Suaeda maritima
Suaeda vera
Succisa pratensis
Teesdalia nudicaulis
Teucrium scorodonia
Thalictrum flavum
Thalictrum minus
Thymus polytrichus
Tilia cordata
Tragopogon pratensis
Trichophorum cespitosum
Triglochin maritimum
Typha angustifolia
Typha latifolia
Utricularia vulgaris
Vaccinium myrtillus
Vaccinium oxycoccus
Valeriana dioica
Valeriana officinalis
Veronica anagallis-aquatica
Veronica montana
Veronica officinalis
Veronica scutellata
Viburnum opulus
Vicia sepium
Vicia sylvatica
Viola odorata
Viola palustris
Viola reichenbachiana
Viola riviniana
Viola tricolour
Zannichellia palustris

Comparisons of the site rankings produced using the new plant indicator species list, the 2001 criteria, and the old and amended site grades.

Scoring v not scoring

There is a very strong positive correlation ($p < 0.01$) between the rankings produced using the species lists with scores and without scores, within the three main habitat types (see table 8). Therefore there is no advantage in using scores, and a straight species list is sufficient.

Table 8 Results: Sites ranked using species lists from the 2001 criteria with scoring v no scores

	Neutral grassland	Ponds and lakes	Woodland
r_s =	0.983	0.990	0.990
n =	49	29	77
C_v =	0.372	0.475	0.325
p =	**< 0.01**	**< 0.01**	**< 0.01**

2001 criteria v new species list

All sites: There is a strong positive correlation ($p < 0.01$) between the rankings produced using the 2001 criteria and the new species list when habitat is ignored (see table 9). This also shows that the score transformation is a valid method for comparison.

Separate habitats: There are strong positive correlations ($p < 0.01$) between the rankings produced using the 2001 criteria by habitat and the new species list (see table 9).

Table 9 Results: Sites ranked using 2001 criteria v new species list

	All sites	Neutral grassland	Ponds and lakes	Woodland
r_s =	0.868	0.945	0.927	0.887
n =	181	49	29	77
C_v =	0.254	0.372	0.475	0.302
p =	**< 0.01**	**< 0.01**	**< 0.01**	**< 0.01**

2001 criteria & new species list v old grades

All sites: There is a strong positive correlation ($p < 0.01$) between the original site grades and the rankings produced by both the 2001 criteria and the new species list when habitat is ignored (see table 10).

Separate habitats: For neutral grassland and woodland, there are strong positive correlations ($p < 0.01$) between the original site grades and the rankings produced by both the 2001 criteria and the new species list. For ponds and lakes there is positive correlation ($p < 0.05$) between the original site grades and the rankings produced by the new species list, but there is no positive correlation ($p > 0.10$) with the 2001 criteria (see table 10). This shows the value in a combined list rather than separate habitat lists.

Table 10 Results: Sites ranked using 2001 criteria and new species list v old grades

		All sites	Neutral grassland	Ponds and lakes	Woodland
2001 criteria	r_s =	0.617	0.598	0.309	0.726
	n =	140	26	25	69
	C_v =	0.254	0.501	0.337	0.325
	p =	**< 0.01**	**< 0.01**	**> 0.10**	**< 0.01**
New species list	r_s =	0.653	0.598	0.419	0.660
	n =	140	26	25	69
	C_v =	0.254	0.501	0.399	0.325
	p =	**< 0.01**	**< 0.01**	**< 0.05**	**< 0.01**

Old grades v amended grades

There is a strong positive correlation ($p < 0.01$) between the rankings produced by using the original site grades and the 2001 amended grades (see table 11). Therefore, generally the quality of the sites has not changed much over the years.

Table 11 Results: Sites ranked using old grades v amended grades

	All sites
r_s =	0.762
n =	92
C_v =	0.267
p =	**< 0.01**

2001 criteria & new species list v amended grades

There is a strong positive correlation ($p < 0.01$) between the amended site grades and the rankings produced by both the 2001 criteria and the new species list, both with all the sites combined, and in separate habitats.

Table 12 Results: Sites ranked using 2001 criteria and new species list v amended grades

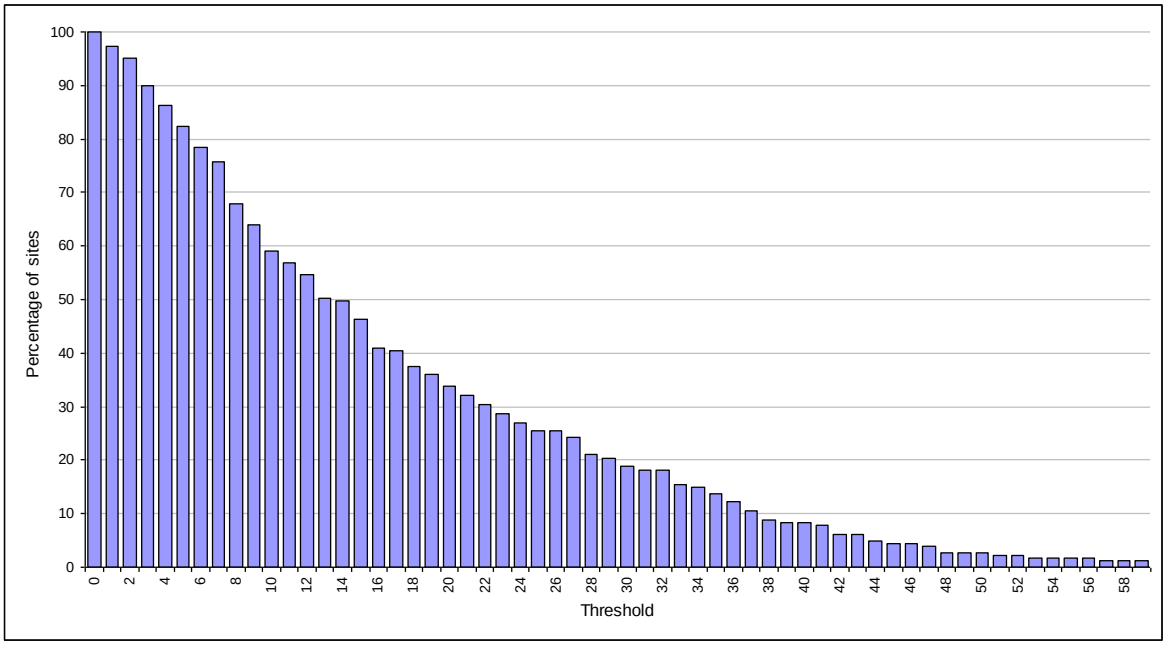
		All sites	**Neutral grassland**	**Ponds and lakes**	**Woodland**
2001 criteria	r_s =	0.746	0.731	0.896	0.768
	n =	92	23	15	44
	C_v =	0.267	0.532	0.658	0.393
	p =	**< 0.01**	**< 0.01**	**< 0.01**	**< 0.01**
New species list	r_s =	0.784	0.774	0.895	0.752
	n =	92	23	15	44
	C_v =	0.267	0.532	0.658	0.393
	p =	**< 0.01**	**< 0.01**	**< 0.01**	**< 0.01**

Threshold scoring levels

As each site is scored, the score can be used to decide whether a site is designated as a Local Wildlife Site. A threshold level can be set, so that sites that score higher than the threshold are selected for designation.

Figure 1 shows the percentage of sites that would score above different threshold levels – 100% at a threshold of zero and onwards. There are no obvious levelling-off points until threshold levels of around 38 and above are reached, where less than 10% of the sites would pass.

Figure 1: Chart of percentage of sites scoring above different threshold levels



Looking at the grades previously awarded to the sites surveyed, 13.3% were SSSIs, 43.6% were SNCIs graded A*, A or B, 19.9% were SNCIs graded C, 16.6% were ungraded SNCIs, and 6.6% were new sites. Therefore, if the number of sites designated as Wildlife Sites was to remain around the same as those designated as SNCIs, 74% of the previously graded sites would need to score above the threshold level. This would require a threshold of 7 (75.7%) or 8 (68.0%). Selecting half of the sites surveyed would require a threshold of 13 (50.3%).

DISCUSSION

This study identifies a quick method to identify sites of nature conservation value within a county that is generally regarded as being under-recorded for most species groups, with an out-of-date local sites system that does not stand up to scrutiny, and where full site survey information will not be available in the near future. This system allows for quick analysis of basic vascular plant species lists, either from recent surveys, or using older data if necessary.

The analysis has shown that there is no advantage to using species weightings, nor to having separate habitat-based species lists. All the site rankings produced were strongly positively correlated, with a slightly stronger positive correlation using the new vascular plant indicator list with both types of site grade than using the original draft criteria. Therefore, using the new vascular plant indicator species list produces a result that is at least as valid as that produced using the original draft criteria or subjective gradings.

Identifying sites

Sites can be identified as potential Local Wildlife Sites using existing data from previous surveys, either because a site was already identified as a Site of Nature Conservation Interest, or because it has been recorded by local naturalists or other surveyors. They can then be resurveyed to provide up-to-date records for analysis against the list of indicator species.

In order to try to have consistency in survey effort for each site surveyed, basic guidelines for surveyors could be drawn up, covering, for example, timings of surveys during the year, amount of time spent on site, and experience of surveyors.

Scoring sites

Using the Recorder 2002 database (which was not available to the researcher at the start of this project), a “rucksack” of the species in the new list can be produced that can be used as a filter for species survey data. Therefore, if the database holds records from a number of different sites, these can be filtered through the rucksack to produce lists of only those indicator species recorded on each site, which can then be counted to produce a site score. This is an extremely quick method of evaluating sites against the list of indicator species.

Selecting Local Wildlife Sites

A threshold score level will have to be agreed upon, above which sites are automatically selected for inclusion in the Wildlife Sites system, and below which other factors may be considered. The threshold level chosen will affect the number of sites selected and designated as Wildlife Sites, and may also affect the way the system is viewed, i.e. if too many sites are chosen the system may become devalued.

Future analysis

As more up-to-date site survey data becomes available, especially of sites containing different habitats, more analysis could be carried to see if the new species list continues to identify all sites of nature conservation value, or if species should be added or removed. A threshold level could also be set more accurately with more sites data available.

The correlations between the rankings produced by both the 2001 criteria and the new species list are more strongly positive between the amended sites grades than the original grades, showing that, although the quality of the sites may not have changed much, this does suggest that there have been some changes. It would be interesting to compare the rankings produced using the 2001 criteria and new species list with the records from when the original site grades were awarded to see if the correlation was stronger then. This would also show how subjectively, or not, the grades were awarded.

As more data relating to different species becomes available, a similar process could be undertaken to produce lists of indicators species for these groups, which could be used in conjunction with the vascular plant indicator species list in identifying sites. It has been shown (Sauberer *et al*. 2004) that birds could be used as a surrogate taxon

Recording change

As sites are resurveyed over the years, a basic indicator of change will be the number of new sites identified that pass the threshold level, and the number of previously identified sites whose condition has fallen below the threshold level. The total area covered by sites could also be used, as could the level of fragmentation.

Data relating to individual sites will show changes in the frequency of species, i.e. whether the same species are recorded on a site, or if species have been gained or lost.

While surveying, if a measure of abundance is recorded for each species, for example using the DAFOR scale (dominant, abundant, frequent, occasional, rare), then changes in species abundance could also be analysed.

This type of monitoring data can help to inform land management both on and off site, for example, associated with agri-environment schemes, and can flag up long-term changes in species frequency and abundance, such as those associated with climate change.

APPENDIX 1

SSSI Condition Monitoring

Lowland Grassland (Robertson & Jefferson 2000)

Appendix 1

Table 4. Positive indicator species in grassland types

Table 5. Negative indicator species in grassland types

Table 4. Positive indicator species in grassland types

Species	MG2	CG1	CG2	CG3,4,5	CG6, MG1-CG2-rel	CG7a,b,d,e /U1b,c,d,f	Lichen grassland CG7c/U1a	CG8	CG9	U1a,U3,U4a,c ,U4/U20-rel	MG3	MG4	MG5	MG8south, M22,M23	Ag-Cx, MG11-MG13-rel	M24,M25	M26,MG8 north,MG 3-rel	OV37
Achillea ptarmica														O/F	O/F		O/F	
Acinos arvensis (Clinopodium acinos)		O/F																
Agrimonia eupatoria					O/F								O/F					
Agrostis curtisii										F-80% cover (U3)								
Aira spp						O/F												
Ajuga reptans																	O/F	
Alchemilla spp	O/F										O/F		O/F					
Anagallis tenella																O/F		
Anenome nemorosa										O/F	O/F		O/F					
Angelica sylvestris	O/F															O/F		
Antennaria dioica								Present	O/F									
Anthyllis vulneraria		O/F	O/F	O/F				O/F										
Aphanes spp						O/F												
Arenaria serpyllifolia		O/F																
Armeria maritima									O/F									O
Asperula cynanchica			O/F	O/F					O/F									
Astragalus danicus						O/F												
Betula erecta														O/F				
Brachypodium pinnatum				F														
Bromopsis erecta				F														
Calluna vulgaris										O/F								
Caltha palustris														O/F	O/F		O/F	
Campanula glomerata			O/F	O/F														
Campanula rotundifolia									O/F	O/F								
Cardamine pratensis														O/F	O/F			
Carlina vulgaris		O/F							O/F									
Carum verticillatum																O/F		
Centaurea nigra	O/F				O/F						O/F	O/F	O/F					
Centaurea scabiosa					O/F													

Species	MG2	CG1	CG2	CG3,4,5	CG6, MG1-CG2-rel	CG7a,b,d,e /U1b,c,d,f	Lichen grassland CG7c/U1a	CG8	CG9	U1e,U3,U4a,c ,U4/U20-rel	MG3	MG4	MG5	MG8south, M22,M23	Ag-Cx, MG11-MG13-rel	M24,M25	M26,MG8 north,MG 3-rel	OV37
Centaurium erythraea		O/F				O/F												
Cirsium acaule			O/F	O/F														
Cirsium dissectum														O/F		O/F		
Cirsium heterophyllum	O/F										O/F							
Cladonia spp						O/F				O/F								
Cinopodium vulgare					O/F													
Cochlearia pyrenaica									O/F									O
Conopodium majus											O/F							
Crepis paludosa																	O/F	
Dianthus deltoides						O/F												
Draba incana									O/F									
Dryas octopetala									O/F									
Eleocharis spp															O/F			
Epipactis atrorubens								Present										
Erica spp										O/F								
Erica tetralix																O/F		
Erigeron acer						O/F												
Erodium cicutarium						O/F												
Eupatorium cannabinum														O/F		O/F		
Euphrasia spp									O/F		O/F		O/F				O/F	
Fern spp. ex Pteridium	O/F																	
Filipendula ulmaria	O/F										O/F	O/F	O/F	O/F	O/F	O/F	O/F	
Filipendula vulgaris			O/F	O/F					O/F			O/F	O/F					
Fragaria vesca						O/F												
Fritillaria meleagris												Extent within 25%						
Galium palustre/G.uliginosum													O/F	O/F	O/F	O/F		
Galium saxatile										O/F								
Galium sterneri									O/F									
Galium verum	O/F	O/F		O/F	O/F	O/F		O/F		O/F		O/F	O/F					
Genista tinctoria													O/F					

Species	MG2	CG1	CG2	CG3,4,5	CG6, MG1-CG2-rel	CG7a,b,d,e /U1b,c,d,f	Lichen grassland CG7c/U1a	CG8	CG9	U1e,U3U4a,c ,U4/U20-rel	MG3	MG4	MG5	MG8south, M22,M23	Ag-Cx, MG11-MG13-rel	M24,M25	M26,MG8 north,MG 3-rel	OV37
Gentiana verna									O/F									
Gentianella spp			O/F	O/F				O/F	O/F									
Geranium sanguineum					O/F													
Geranium sylvaticum	O/F										O/F							
Geum rivale	O/F										O/F			O/F			O/F	
Helianthemum canum (H.oelandicum)									O/F									
Helianthemum nummularium		O/F	O/F	O/F		O/F		O/F	O/F									
Hippocrepis comosa			O/F	O/F					O/F									
Hoary leaved Helianthemum (H. appeninum/H. canum)		O/F																
Hydrocotyle vulgaris														O/F				
Hypericum montanum								Present										
Hypericum pulchrum								O/F										
Jointed rushes														O	O/F			
Knautia arvensis					O/F													
Lathyrus linifolius (L.montanus)										O/F			O/F					
Lathyrus pratensis					O/F						O/F	O/F	O/F					
Leontodon autumnalis												O/F			O/F			
Leontodon hispidus					O/F				O/F									
Leontodon hispidus/L.saxatilis		O/F	O/F	O/F		O/F							O/F					
Leontodon spp											O/F		O/F				O/F	
Leucanthemum vulgare			O/F	O/F								O/F	O/F					
Lichen species		Cover >5%					O/F											
Linum anglicum (L. perenne)								Present										
Linum catharticum		O/F	O/F	O/F				O/F										
Listera ovata								O/F										
Lotus corniculatus		O/F	O/F	O/F	O/F	O/F		O/F	O/F	O/F	O/F	O/F	O/F					
Lotus pedunculatus														O/F		O/F		
Lychnis flos-cuculi														O/F	O/F		O/F	
Lysimachia nummularia															O/F			
Mentha aquatica														O/F	O/F			

Species	MG2	OG1	OG2	OG3,4,5	OG6, MG1-CG2-rel	OG7a,b,d,e /U1b,c,d,f	Lichen grassland OG7c/U1a	OG8	OG9	U1e,U3U4a,c ,U4/U20-rel	MG3	MG4	MG5	MG8south, M22,M23	Ag-Cx, MG11-MG13-rel	M24,M25	M26,MG8 north,MG 3-rel	OV37
Mercurialis perennis	O/F																	
Minuartia verna																		O
Molinia caerulea																F-80% cover	F-80% cover (M26)	
Myosotis alpestris									O/F									
Myosotis laxa/M. scorpioides															O/F			
Narthecium ossifragum																O/F		
Oenanthe fistulosa															O/F			
Oenanthe silaifolia												O/F						
Orchidaceae spp					O/F									O/F		O/F	O/F	
Origanum vulgare					O/F													
Ornithopus perpusillus						O/F												
Parnassia palustris								Present	O/F									
Pedicularis sylvatica										O/F						O/F		
Persicaria amphibia															O/F			
Persicaria bistorta											O/F	O/F						
Persicaria vivipara									O/F									
Pilosella officinarum (Hieracium pilosella)		O/F	O/F	O/F		O/F			O/F	O/F								
Pimpinella saxifraga								O/F					O/F					
Pimpinella spp					O/F													
Pinguicula vulgaris								Present	O/F									
Plantago coronopus						O/F												
Plantago maritima								Present	O/F									
Plantago media			O/F	O/F				O/F										
Polemonium caeruleum	O/F																	
Polygala spp			O/F	O/F				O/F		O/F			O/F					
Potentilla erecta										O/F			O/F			O/F	O/F	
Potentilla palustris														O/F				
Primula farinosa								Present	O/F									
Primula veris			O/F	O/F	O/F			O/F				O/F	O/F					
Pteridium aquilinum										50-90% cover								

Species	MG2	OG1	OG2	OG3,4,5	OG6, MG1-OG2-rel	OG7a,b,d,e /U1b,c,d,f	Lichen grassland OG7c/U1a	OG8	OG9	U1e,U3U4a,c ,U4/U20-rel	MG3	MG4	MG5	MG8south, M22,M23	Ag-Cx, MG11-MG13-rel	M24,M25	M26,MG8 north,MG 3-rel	OV37
										(U4/U20-rel)								
Ranunculus flammula														O/F	O/F			
Rare and scarce lichens							Present & extent											
Rhinanthus minor											O/F	O/F	O/F				O/F	
Rumex acetosella						O/F				O/F								
Sanguisorba minor		O/F	O/F	O/F	O/F			O/F	O/F				O/F					
Sanguisorba officinalis	O/F										O/F	O/F	O/F				O/F	
Saxifraga hypnoides									O/F									
Scabiosa columbaria		O/F	O/F	O/F				O/F	O/F									
Scilla spp.		O/F																
Sedum acre						O/F												
Sedum spp.		O/F																
Selaginella selaginoides								Present	O/F									
Serratula tinctoria			O/F							O/F		O/F	O/F			O/F	O/F	
Sesleria caerulea								F	F									
Silaum silaus												O/F	O/F					
Silene uniflora																		O
Small blue-green Carex spp.													O/F	O/F	O/F	O/F	O/F	
Sphagnum spp																O/F		
Stachys officinalis								O/F		O/F		O/F	O/F					
Succisa pratensis	O/F		O/F	O/F				O/F	O/F	O/F	O/F	O/F	O/F	O/F		O/F	O/F	
Teesdalia nudicaulis						O/F												
Teucrium scorodonia					O/F					O/F								
Thlaspi caerulescens																		O
Thalictrum flavum												O/F		O/F	O/F			
Thymus polytrichus								O/F	O/F									
Thymus spp		O/F	O/F	O/F	O/F	O/F												
Tragopogon pratensis					O/F							O/F	O/F					
Trinia glauca		O/F																
Trollius europaeus								Present			O/F						O/F	
Vaccinium myrtillus										O/F								

Species	MG2	OG1	OG2	OG3,4,5	OG6, MG1-CG2-rel	OG7a,b,d,e /U1b,c,d,f	Lichen grassland CG7c/U1a	OG8	OG9	U1e,U3,U4a,c ,U4/U20-rel	MG3	MG4	MG5	MG8south, M22,M23	Ag-Cx, MG11-MG13-rel	M24,M25	M26,MG8 north,MG 3-rel	OV37
Valeriana dioica														O/F		O/F	O/F	
Valeriana officinalis	O/F																	
Veronica officinalis										O/F						O/F		
Viola hirta								O/F										
Viola lutea																		O
Viola palustris														O/F		O/F		
Viola spp										O/F								
O = Occasional																		
F = Frequent																		

Table 5. Negative indicator species in grassland types

Species	MG2	OG1	OG2	OG3,4,5	OG6, MG1-CG2-rel	OG7a,b,d,e/U1b,c,d,f	Lichen grassland CG7c/U1a	OG8	OG9	U1e,U3, U4a,c	U4/U20-rel	MG3	MG4	MG5	MG8south, MG8-rel	MG8north, MG3-rel	Ag-Cx, MG11-MG13-rel	M22, M23	M24, M25	M26	OV37
Agrostis curtisii										>80% cover	>80% cover										
Anthriscus sylvestris	<25% cover											<+F/5% cover	<F/5% cover	<F/5% cover		<F/5% cover				<F/5% cover	<F/5% cover
Brachypodium pinnatum			<10% cover	<10% cover (OG3)																	
Bromopsis erecta			<10% cover																		
Carduus nutans						<F/5% cover	<F/5% cover														
Chamerion angustifolium						<F/5% cover	<F/5% cover	<F/5% cover		<F/5% cover	<F/5% cover										
Cirsium arvense	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover
Cirsium palustre										<F/5% cover	<F/5% cover								<20% cover		
Cirsium vulgare	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover

Species	MG2	CG1	CG2	CG3,4,5	CG6, MG1-CG2-rel	CG7a,b,d,e/U1b,c,d,f	Lichen grassland CG7c/U1a	CG8	CG9	U1e,U3,U4a,c	U4/U20-rel	MG3	MG4	MG5	MG8south, MG8-rel	MG8north, MG3-rel	Ag-Cx, MG11-MG13-rel	M22, M23	M24, M25	M26	OV37
Coarse grasses		<F/5% cover				<10% cover	<F/5% cover			<10% cover	<10% cover										<F/5% cover
Deschampsia cespitosa													<10% cover	<10% cover	<10% cover	<10% cover	<25% cover	<10% cover	<10% cover	<10% cover	
Deschampsia flexuosa						<20% cover															
Galium aparine								<F/5% cover						<F/5% cover							
Heracleum sphondylium																					<F/5% cover
Jointed rushes																<50%		<80% cover	<80% cover	<80% cover	
Juncus conglomeratus/J. effusus/J. inflexus																<25%		<50% cover	<50% cover	<50% cover	
Juncus spp													<10% cover	<10% cover	<10% cover		<25% cover				
Large Carex spp													<10% cover	<10% cover	<10% cover		<25% cover	<20% cover			
Large grasses													<10% cover	<10% cover	<10% cover		<25% cover	<10% cover			
Molinia caerulea																			>80% cover	>80% cover	
Myrica gale																			<10% cover		
Phragmites australis																<5% cover			<10% cover	<5% cover	
Plantago major						<F/5% cover	<F/5% cover			<F/5% cover	<F/5% cover			<F/5% cover							
Pleurocarpous bryophytes							<50% cover														
Pteridium aquilinum	<F/5% cover					<10% cover	<F/5% cover		<10% cover	<20% cover	<50% or >90% cover			<F/5% cover							
Rhododendron spp						<1% cover				<1% cover	<1% cover										

Species	MG2	CG1	CG2	CG3,4,5	CG6, MG1-CG2-rel	CG7a,b,d,e/U1b,c,d,f	Lichen grassland CG7c/U1a	CG8	CG9	U1e,U3, U4a,c	U4/U20-rel	MG3	MG4	MG5	MG8south, MG8-rel	MG8north, MG3-rel	Ag-Cx, MG11-MG13-rel	M22, M23	M24, M25	M26	OV37
Rosa spp								<10% cover													
Rumex crispus	<F/5% cover		<F/5% cover	<F/5% cover	<F/5% cover							<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	
Rumex obtusifolius	<F/5% cover		<F/5% cover	<F/5% cover	<F/5% cover							<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	
Scrub/tree spp	<30% cover	<5% cover	<5% cover	<5% cover	<30% cover	<5% cover	<1% cover	<5% cover	<5% cover	<5% cover	<5% cover	<F/1% cover	<F/1% cover	<5% cover	<5% cover	<5% cover	<5% cover	<5% cover	<5% cover	<5% cover	<5% cover
Senecio aquaticus													<F	<F/5% cover	<F/5% cover		<F/5% cover	<F/5% cover	<F/5% cover		
Senecio jacobaea	<F/5% cover	<F	<F/5% cover	<F/5% cover	<F/5% cover	<F	<F	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover							
Sonchus spp								<F/5% cover													
Ulex spp										<30% cover	<30% cover										
Urtica dioica	<25% cover		<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover	<F/5% cover
F = Frequent																					

NB Some taxa should be considered together with others. See field forms for details

APPENDIX 2

SSSI Condition Monitoring

Lowland Heathland (Alonson *et al.* 2003)

Annex 2. Dry heath field form

Annex 3. Wet heath field form

Annex 2. DRY Lowland Heathland - Condition Assessment field form

Site Name:	**Grid reference (if known):**	**Assessed by:**
Date: **Time:**	**Photographs taken - Film and Frame Nos.**	**NVC type (if available)**

Condition (please circle): Favourable maintained / Favourable recovered / Unfavourable recovering / Unfavourable no change / Unfavourable declining / Partially destroyed / Destroyed

Recommended visiting period: May-October

Recommended frequency of visits: **Every six years for national reporting**

Key management activities affecting condition to discuss with manager:

Grazing intensity/stocking rate	Burning / presence of fire-breaks	
Stock type	Rolling and chain harrowing	
Grazing period	Bracken management	
Supplementary feeding	Other (specify)	
Scrub and weed control	Manag. agreement/scheme/grant	Yes/No
Cutting	Agri-env. schemes/grants	Yes/No

Other activities likely to have an impact (tick + or - if appropriate)

Farming/agriculture	Military activities
Conservation activities	Mineral extraction
Urbm development	Natural events
Forestry	Recreation/tourism
Infrastructure/transport	Water abstraction

Structured walk Frequencies: totals out of 20 stops. 1-2 = **rare**, 3-6 = **occasional**, 7-12 = **frequent**, all stops (<50% cover) = **abundant**, all stops (>50% cover) = **dominant**. An A4 is appr. 1.5% of a 2x2m quadrat.

Attribute (*= mandatory attribute. One failure among mandatory attributes = unfavourable condition)	**Target (for the entire feature)**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**Estimate for attribute**
***Extent of habitat**	No un-consented loss of area	(Describe and refer to map)																				
***Bare ground (not rock)** % cover of ephemerally exposed bare ground in intimate mosaic with vegetation or in tracks/paths	'Undisturbed' 1-10% 'Heavily disturbed' <1%																					
***Vegetation structure**																						
TOTAL % cover shrubs	Cover of dwarf shrubs between 25-90%																					
Ulex spp. cover	<50%																					
Calluna vulgaris (pseudo-Pioneer %	10-40%																					
(when possible to Building/Mature %	20-80%																					
Differentiate) Degenerate %	<30%																					
Dead %	<10%																					
***Vegetation composition**	Lists to be tailored to each site																					
Dwarf shrubs Frequency of any of the following species: *Arctostaphylos uva-ursi, Calluna vulgaris, Erica ciliaris, Erica cinerea, Erica tetralix, Erica vagans, Ulex gallii, Ulex minor, Vaccinium myrtillus, V. vitis-idaea, Genista anglica, Empetrum nigrum.*	At least 2 species at least **frequent** (see guidance for species-poor sites)																					
Graminoids Frequency of any of the following species: *Agrostis* spp., *Ammophila arenaria, Carex* spp., *Danthonia decumbens, Deschampsia flexuosa**, *Festuca* spp., *Molinia caerulea, Nardus stricta**, *Trichophorum cespitosum.*	At least 1 species at least **frequent** and 2 species at least **occasional** throughout the sward (see guidance for species-poor/rich sites) except *, which should be not more than occasional & <25% cover.																					

Attribute (*= mandatory attribute. One failure among mandatory attributes = unfavourable condition)	Target (for the entire feature)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Estimate for attribute
Desirable forbs Frequency of any of the following species *Armeria maritima, Galium saxatile, Genista anglica, Hypochaeris radicata, Lotus corniculatus, Plantago lanceolata, Plantago maritima, Polygala serpyllifolia, Potentilla erecta, Rumex acetosella, Scilla verna, Serratula tinctoria, Thymus praecox, Viola riviniana.* Limestone heath only: *Filipendula vulgaris, Galium verum, Helianthemum nummularium, Sanguisorba minor.* Dune heath only: *Aira praecox, Corynephorus canescens, Phleum arenarium, Erodium cicutarium, Filago minima, Sedum acre, Polygala*	At least 2 species at least **occasional** (see guidance for species-poor/rich sites)																					
Bryophytes and lichens Cover of all spp. (except dense acrocarpous spp.) eg *Cladonia* spp., *Dicranum scoparium, Hylocomium splendens, Hypnum cupressiforme, Pleurozium schreberi, Polytrichum* spp., *Racomitrium lanuginosum.*	Site-specific target to be set (see guidance)																					
***Negative indicators**	List to be tailored to each site																					
Signs of disturbance Record presence of erosion.	<1% of habitat showing signs of erosion.																					
Species (-ve if over target threshold) % cover of any of the following species: *Rhododendron ponticum, Gaultheria shallon, Fallopia japonica,*	(% of entire feature) *Rhododendron* and exotic species <1%.																					
Cirsium arvense, Digitalis purpurea, Epilobium spp. *(excl. E. palustre), Chamerion angustifolium, Juncus effusus, J. squarrosus, Ranunculus* spp., *Senecio* spp., *Rumex obtusifolius, Urtica dioica,* coarse grasses,	< 1 % *Senecio* spp., *Urtica dioica, Cirsium* spp. and other herbaceous, in clumps.																					
Betula spp., *Prunus spinosa, Pinus* spp., *Rubus* spp., *Cytisus scoparius, Quercus* spp., *Hippophae rhamnoides*	< 15% trees, tree seedlings or other species of scrub. <1% *Rubus* spp. (see guidance 12.6)																					
Pteridium aquilinum.	< 10% *P. a.* in dune grassy																					
Ulex europaeus.	<25% *U. europaeus*																					
Dense mats of acrocarpous mosses (*C. introflexus*).	Acr. mosses < occasional																					
Indicators of local distinctiveness	List to be tailored to each site																					
Rare species, pools, edges Eg *Cladonia arbuscula, Cladonia incrassata, Cornicularia* spp., *Viola lactea,* etc.	Monitor and set targets according to cons. objectives or management plan.																					

Annex 3. WET Lowland Heathland - Condition Assessment field form

Site Name:		**Grid reference (if known):**	**Assessed by:**
Date:	**Time:**	**Photographs taken - Film and Frame Nos.**	**NVC type (if available)**

Condition (please cirdle): Favourable maintained / Favourable recovered / Unfavourable recovering / Unfavourable no change / Unfavourable declining / Partially destroyed / Destroyed

Recommended visiting period: May-October

Recommended frequency of visits: Every six years for national reporting

Key management activities affecting condition to discuss with manager:

Grazing intensity/stocking rate Burning / presence of fire-breaks
Stock type Rolling and chain harrowing
Grazing period Bracken management
Supplementary feeding Other (specify)
Scrub and weed control Manag. agreement/scheme/grant Yes/No
Cutting Agri-env. schemes/grants Yes/No

Other activities likely to have an impact (tick + or - if appropriate)

Farming/agricultureMilitary activities
Conservation activities Mineral extraction
Urbm developmentNatural events
Forestry Recreation/tourism
Infrastructure/transport Water abstraction

Structured walk Frequencies: totals out of 20 stops. 1-2 = **rare**, 3-6 = **occasional**, 7-12 = **frequent**, all stops (<50% cover) = **abundant**, all stops (>50% cover) = **dominant**. An A4 is appr. 1.5% of a 2x2m quadrat.

Attribute (*= mandatory attribute. One failure among mandatory attributes = unfavourable condition)	**Target (for the entire feature)**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**Estimate for attribute**
***Extent of habitat**	No un-consented loss of area	(Describe and refer to map)																				
***Bare ground (not rock)** % cover of ephemerally exposed bare ground in intimate mosaic within vegetation and in tracks/paths.	'Undisturbed' 1-10% 'Heavily disturbed' <1%																					
***Vegetation structure**																						
TOTAL % cover shrubs	Cover of dwarf shrubs: 25-90%																					
Calluna vulgaris	Presence of heather in all stages of growth. No one growth form should be dominant.																					
***Vegetation composition**	Lists to be tailored to each site																					
Dwarf shrubs Frequency of any of the following species: *Calluna vulgaris, Empetrum nigrum, Erica ciliaris, E. cinerea, E. tetralix, E. vagans, Myrica gale, Salix repens, Ulex gallii, Ulex minor, Vaccinium* spp.	At least 2 species at least **frequent**																					
Graminoids Frequency of any of the following species: *Carex panicea, Carex pulicaris, Eleocharis* spp., *Eriophorum angustifolium, Juncus acutiflorus, Juncus articulatus, Molinia caerulea**, *Rhynchospora alba, Schoenus nigricans*!, *Trichophorum cespitosum*.	At least 1 species at least **frequent** and 2 species at least **occasional** throughout the sward (except *, which should be not more than occasional, and !, which should be >20% when naturally present)																					

Attribute (*= mandatory attribute. One failure among mandatory attributes = unfavourable condition)	Target (for the entire feature)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Estimate for attribute
Desirable forbs Frequency of any of the following species: *Anagallis tenella, Drosera* spp., *Galium saxatile, Genista anglica, Narthecium ossifragum, Pinguicula* spp., *Polygala serpyllifolia, Potentilla erecta, Serratula tinctoria, Succisa pratensis*.	At least 2 species at least occasional																					
Bryophytes and lichens % cover and frequency of: *Sphagnum* spp Locally occurring lichens	when naturally present >10% cover of Sphagna >5% of lichens																					
***Negative indicators**	List to be tailored to each site																					
Signs of disturbance - Drains	Artificial drainage channels adversely affecting hydrology are absent.																					
- Obvious visual pollution.	No signs of silt or leachate.																					
- Trampling	<1% trampling signs/paths (eg on Sphagnum)																					
Species (-ve if over target threshold) % cover of any of the following species: *Rhododendron ponticum*	(% of entire feature) *Rhododendron* and exotic species <1%																					
Apium nodiflorum, Cirsium arvense, Digitalis purpurea, Epilobium spp. (excl. *E. palustre*), *Glyceria fluitans, Juncus effusus, J. squarrosus, Oenanthe crocata, Phragmites* spp., *Ranunculus repens, Fallopia japonica, Senecio jacobaea, Rumex obtusifolius, Typha* spp., *Urtica* spp	<1% undesirable herbaceous/forb spp.																					
Alnus glutinosa, Betula spp., *Pinus* spp., *Prunus spinosa, Quercus* spp., *Rubus* spp., *Salix* spp.	< 10% trees, tree seedlings or other species of scrub.																					
Pteridium aquilinum.	< 5% *P. aquilinum*																					
Ulex spp.	<10% *U. europaeus*																					
Dense mats of acrocarpous mosses (*Campylopus introflexus*).	Acr. mosses < occasional																					
Indicators of local distinctiveness	List to be tailored to each site																					
Rare species, pools, edges Monitor and set targets according to conservation objectives or management plan. *Cicendia filiformis, Gentiana pneumonanthe, Hammarbya paludosa, Lycopodiella inundata, Radiola linoides, Rhynchospora fusca*…																						

APPENDIX 3

Common Standards Monitoring

Common Standards Monitoring Guidance for Coastal Habitats

(JNCC 2004a)

Sand Dune Habitats

11. Generic common standards tables:

Table 2.1 Standline, embryo and mobile dunes

Table 2.2 Fixed dune grassland

Table 2.3 Humid dune slacks

Table 2.4 Dunes with *Salix repens*

Saltmarsh Habitat

14. Generic guidance table

Vegetated Coastal Shingle

17. Generic attributes table

Table 2.1 Strandline, embryo and mobile dunes

Includes the following:

Strandline
Equivalent NVC communities: SD1 (sandy shores only), SD2 (sandy shores only), SD3 (sandy shores only)
Annex I type: Annual vegetation of drift lines (H1210) (see Section 1.2) Phase I category: H5 Strandline vegetation (sandy shores only)

Embryonic shifting dune
Equivalent NVC communities: SD4, SD5.
Annex I type: Embryonic shifting dunes (H2110)
Phase 1 category: H6.8 Open dune (part excluding grey dunes)

Mobile dune
Equivalent NVC communities: SD5, SD6. Plus provisional new types SDx, SDy, SDz, SDxx and SD12z (Dargie 2000)
Annex I type: Shifting dunes along the shoreline with *Ammophila arenaria* (H2120)
Phase 1 category: H6.8 Open dune (part excluding grey dunes)

Reporting category: Supralittoral sediment

NB All attributes listed are mandatory, unless indicated as discretionary or site-specific by *. Some attributes are not applicable to every sub-division. A single failure to achieve a target leads to unfavourable condition for the whole monitoring unit.

Attributes	Targets	Methods of assessment	Comments
Extent of feature	No net decrease in extent from the established baseline, subject to natural change.	A baseline map should be prepared to show the distribution of sand dune vegetation and bare dune, using aerial photography or existing NVC survey data. A comparison with the baseline should be made through maps and/or photographs, checked during the structured walk.	Give sources and dates of maps or photographs. If loss (or gain) of area is due to natural causes this is not a decline in condition, but any significant loss due to human interference (e.g. sand extraction, visitor impacts, ploughing or conversion to improved grassland) is to be regarded as unfavourable. Increase in area is favourable unless related to coast protection. Strandline may be absent in some years as a result of natural causes, but continued absence over the six year period would cause condition to be unfavourable. Extent, particularly of embryonic dunes, may be subject to periodic and seasonal variation

Attributes	Targets	Methods of assessment	Comments
Physical structure: functionality and sediment supply	No further anthropogenic increase in factors leading to the decrease of natural mobility of the system. The natural circulation of sand and organic matter should be retained.	Aerial photographs can be used, combined with information gathered from the site visit	Natural processes, particularly sediment supply, may be interrupted or prevented by coastal protection or artificial stabilisation (other than porous breach repair), by sediment extraction or tree planting. Accumulation of driftline organic material (seaweed etc.) is essential for trapping sand and initiating dune formation. Mechanical beach cleaning can adversely affect this process.
Vegetation structure: range of zones	Zonation from beach to fixed dune should be intact over at least 95 % of coastal frontage	Visual assessment, e.g. using transects (extending from beach to fixed dune) may be used to estimate the width of the strandline, embryonic dune and mobile dune at points described by GPS and marked on a map.	Points may change because of natural dynamism, but the overall diversity should not diminish. The target will be site- and feature-specific, dependent on the dune features present. If strandline is absent this may be acceptable if due to natural causes (see comment under *Extent*). The dune front may be vulnerable to heavy trampling/grazing by stock.
Vegetation composition: typical species	Maintain frequency of characteristic species (see list at the end of the table) of the main sand dune zones as follows: *Strandline: At least one species frequent and another occasional. Embryonic dunes: At least one species frequent. Mobile dunes: At least one species frequent.*	Visual assessment of cover (modified DAFOR scale), using structured walk and transects.	Communities may be dynamic in their distribution and are linked to the physical processes operating at the site. Embryo and mobile dunes a typically species-poor and monospecific stands are common. Additional species may be included in the target on a site-specific basis.
Vegetation composition: condition and flowering/fruiting of foredune grasses	Healthy *Ammophila arenaria, Leymus arenarius* or *Elytrigia juncea* with abundant fruiting heads at least frequent.	Visual assessment of cover (modified DAFOR scale), using structured walk	If flowering is not frequent, dunes are no longer mobile and condition is unfavourable (see text for details).
Vegetation composition: negative indicator species ,	1. Sea buckthorn *Hippophae rhamnoides* should be absent from sites where it is not native. 2. Other non-native species no more than rare. 3. Any one of the following negative indicators no more than frequent throughout the sward, or singly or together the cover of negative indicator species no more than 5%. Negative indicator species: *Senecio jacobaea, Cirsium arvense, Cirsium vulgare, Urtica dioica, Lolium perenne, Arrhenatherum elatius.*	Aerial photographs, together with visual assessment of cover (modified DAFOR scale), using structured walk. % cover measured is cover of the entire feature.	Where ***Hippophae rhamnoides*** is native (in some sites in eastern England) this species is not counted as a negative indicator. It has been widely introduced elsewhere and has proved very invasive. *Urtica dioica* and *Cirsium* species are indicative of poor condition because of enrichment. Abundance of *Senecio jacobaea* indicates overgrazing in summer.

Attributes	Targets	Methods of assessment	Comments
Other negative indicators	Vehicle damage or visitor damage at vulnerable locations (e.g. tracks, access points) should be absent or rare	Visual assessment during site visit	Impact of human activities will depend on the site. Notes should be made of the type of damaging activity, location and extent for future further assessment.
***Indicators of local distinctiveness**	Maintain distinctive elements at current extent/levels and/or in current locations (e.g. maintain existing populations of notable plant or animal species or transitions to non-dune habitats).	Presence confirmed during site visit at appropriate season. List species, add DAFOR score, mark locations on map(s) in file. List to be tailored to each site.	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not adequately covered by the previous attributes, or by separate guidance (e.g. for notified species features). For notable species (e.g. vascular plants) it is not intended to set a target for detailed species monitoring, rather to provide a rapid indication of presence/absence and/or approximate extent, allowing for natural fluctuations in population size. *If the indicators of local distinctiveness form part of the reason for the notification of the site, this is a mandatory attribute.

Table 2.2.1 Typical species for strandline, embryonic dunes and mobile dunes

Typical species	
Strandline	*Cakile maritima, Honckenya peploides, Salsola kali, Atriplex* spp. Scotland: *Matricaria maritima*
Embryonic dunes	*Elytrigia juncea, Leymus arenarius*
Mobile dunes	*Ammophila arenaria, Leymus arenarius*

Table 2.2 Fixed dune grassland

Equivalent NVC communities: SD7, SD8 (except machair), SD9, SD10, SD11, SD12, SD19, CG10, plus Dargie's provisional new SD12y (Dargie, 2000).
Annex I type: Fixed dunes with herbaceous vegetation ('grey dunes') (H2130)
Phase I categories: H6.8 Open dune (grey dunes only); H6.5 Dune grassland

Reporting category: Supralittoral sediment

NB All attributes listed are mandatory, unless indicated as discretionary or site-specific by *. A single failure to achieve a target leads to unfavourable condition for the whole monitoring unit.

Attributes	Targets	Methods of assessment	Comments
Extent of feature	No net decrease in extent from the established baseline, subject to natural change.	A baseline map should be prepared to show the distribution of sand dune vegetation, using aerial photography or existing NVC survey data. A comparison with the baseline should be made through maps and/or photographs, checked during the structured walk.	Give sources and dates of maps or photographs. If loss (or gain) of area is from natural causes this is not a decline in condition, but any significant loss due to human interference (e.g. sand extraction, visitor impacts, ploughing or conversion to improved grassland) is to be regarded as unfavourable. Increase in area is favourable unless related to coast protection or at the expense of other sand dune features.
Vegetation structure: range of zones	Zonation from beach to fixed dune intact over at least 95% of coastal frontage.	The width of zones could be estimated using one or more transects extending from strandline to landward features. Aerial photographs should be used as an aid, where available.	Points may change due to natural dynamism but the overall diversity should not diminish. Mosaics on hindshore systems may make the width of the fixed dune grassland difficult to assess
Vegetation structure: bare ground	Bare ground or sand present, but no more than 10 % total area.	Visual assessment of cover during structured walk or transects. Aerial photographs should be used as an aid, where available.	Patches of bare sand are essential for a wide range of dune invertebrates. Areas of bare sand created by human induced disturbance should not increase.
Vegetation structure: sward height	30-70% of sward to comprise species-rich short turf, 2-10 cm tall.	Assessment during structured walk or transects.	Target for ratio of short turf to taller marram-dominated vegetation should be set on a site-specific basis.

Attributes	Targets	Methods of assessment	Comments
Vegetation structure: flowering/fruiting	Flowering and fruiting of dune grassland to at least frequent level – depending on the time of year visited (May-Oct).	Visual assessment (modified DAFOR scale) during structured walk or transects.	Level and timing of stock grazing should be sufficient to allow adequate seed production. Flowering is also important for many invertebrates (e.g. for nectar).
Vegetation composition: typical species	For calcareous dune grasslands (SD7, SD8, SD9, SD19), at least **eight** typical species (see list at end of table) present at more than occasional level. For acidic dune grasslands (SD12), at least **six** typical species (see list at end of table) present at more than rare level.	Visual assessment of cover (modified DAFOR scale), using structured walk or transects.	Other species may be included on a site specific basis (see also *Indicators of local distinctiveness*).
Vegetation composition: negative indicator species	1. Non-native species, including sea buckthorn *Hippophae rhamnoides* where introduced, no more than rare. 2. Other non-native species no more than rare. 3. Any one of the other negative indicators no more than frequent throughout the sward, or singly or together the cover of negative indicator species no more than 5%. Negative indicator species: *Senecio jacobaea, Rosa spp., Cirsium arvense, Cirsium vulgare, Urtica dioica, Lolium perenne, Arrhenatherum elatius* (not SD9), *Pteridium aquilinum, Rubus fruticosus.*	Visual assessment of cover (modified DAFOR scale), using structured walk or transects. % cover measured is cover of the entire feature.	Where ***Hippophae rhamnoides*** is native (in some sites in eastern England) this species is not counted as a negative indicator. It has been widely introduced elsewhere and has proved very invasive. *Urtica dioica* and *Cirsium* spp. are indicative of poor condition Abundance of *Senecio jacobaea* indicates overgrazing in summer. *Lolium perenne* is indicative of agricultural improvement.
Vegetation composition: scrub/trees	Scrub/trees no more than occasional, or less than 5% cover (except *Juniperus* spp in Scotland). Tree invasion from adjacent plantations absent or rare.	Visual assessment of cover (modified DAFOR scale), using structured walk or transects. % cover measured is cover of the entire feature.	See comments above about ***Hippophae rhamnoides.*** Where scrub or woodland is a notified habitat feature, the woodland monitoring guidance should be consulted.
Other negative indicators	Vehicle damage or trampling at vulnerable locations (tracks, access points) should be absent or rare.	Visual assessment during site visit	

Attributes	Targets	Methods of assessment	Comments
***Indicators of local distinctiveness**	Maintain distinctive elements at current extent/levels and/or in current locations (e.g. maintain existing populations of notable plant or animal species or transitions between habitats).	Presence confirmed during site visit at appropriate season. (List species, add DAFOR score, mark locations on map(s) in file.) List to be tailored to each site.	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not adequately covered by the previous attributes , or by separate guidance e.g. for notified species features.For notable species (e.g. vascular plants) it is not intended to set a target for detailed species monitoring, rather to provide a rapid indication of presence/absence and/or approximate extent, allowing for natural fluctuations in population size. *If part of the reason for the notification of the site, this is a mandatory attribute.

Table 2.2.1 Typical Species for fixed dune grassland

Calcareous dune grasslands (SD7, 8, 9, 19)			**Acidic dune grasslands (SD12)**	
Aira praecox	*Geranium molle*	*Rhinanthus minor*	*Aira praecox*	*Lotus corniculatus*
Arrhenatherum elatius **(SD 9 only)**	*Hypnum cupressiforme*	*Rhytidiadelphus squarrosus*	*Agrostis capillaris*	*Luzula campestris*
Astragalus danicus	*Hypochaeris radicata*	*Rhytidiadelphus triquetrus*	*Astragalus danicus*	*Pilosella officinarum*
Carex arenaria	*Linum catharticum*	*Thymus praecox*	*Carex arenaria*	*Polygala serpyllifolia*
Carex flacca	*Lotus corniculatus*	*Tortula muralis*	*Carex pilulifera*	*Plantago lanceolata*
Cerastium fontanum	*Luzula campestris*	*Trifolium repens*	*Cladonia* spp	*Pleurozium schreberi*
Crepis capillaris	*Odontites verna*	*Sedum acre*	*Deschampsia flexuosa*	*Potentilla erecta*
Cladonia spp.	*Ononis repens*	*Veronica chamaedrys*	*Dicranum scoparium*	*Scleropodium purum*
Erodium cicutarium	*Peltigera* spp.	*Viola canina*	*Festuca ovina*	*Thymus praecox*
Euphrasia officinalis	*Pilosella officinarum*	*Viola riviniana*	*Galium saxatile*	*Trifolium repens*
Festuca rubra	*Plantago lanceolata*	*Viola tricolor*	*Hylocomium splendens*	*Veronica chamaedrys*
Galium verum	*Prunella vulgaris*		*Hypochaeris radicata*	*Viola canina*

Table 2.3 Humid dune slacks

Equivalent NVC communities: SD13, SD14, SD15, SD16 (part), SD17
Annex I type: Humid dune slacks (H2190)
Phase I category: H6.4 Dune slacks

Reporting category: Supralittoral sediment

NB All attributes listed are mandatory, unless indicated as discretionary or site-specific by *. A single achieve a target leads to unfavourable condition for the whole monitoring unit.

Attributes	Targets	Methods of assessment	Comments
Extent of feature	No net loss of area.	A baseline map should be prepared to show the distribution of the dune slacks, using aerial photography or existing NVC survey data. A comparison with the baseline should be made through maps and/or photographs, checked during the structured walk.	Give sources and dates of maps or photographs. If loss (or gain) of area is from natural causes this is not a decline in condition, but any significant loss due to human interference (e.g. sand extraction, visitor impacts, ploughing or conversion to improved grassland) is to be regarded as unfavourable. Increase in area is favourable unless related to coast protection or at the expense of other sand dune features.
Vegetation structure: range of zones	All humid dune slack communities should be present – from embryonic dune slacks with a high percentage of bare ground to those with more closed vegetation and up to 33% cover of *Salix repens* .Early dune slack successional stages at least occasional.	Visual assessment during structured walk and transects.	Further research is required to define the attributes of early dune slack successional stages
Vegetation structure: bare ground	Bare ground or sand present, but less than 5% of the total dune slack area.	Visual assessment of cover during structured walk and transects. Aerial photographs should be used as an aid, where available.	Bare ground target may need to be revised in view of the need for the presence of early dune slack successional stages. There is also a link across to lower plant condition assessment.
Vegetation composition: forb/grass ratio	The sward should contain >30% cover of forbs and <70% cover of grasses.	Visual assessment of cover during structured walk and transects.	Drying and eutrophication of the slack can be indicated by increase in 'grassiness'.

Vegetation composition: typical species	**Four** or more typical species (see list at end of table) at least frequent and **two** or more others at least occasional. Bryophytes (e.g. *Calliergon cuspidatum, Campylium stellatum*) at least occasional.	Visual assessment of cover (modified DAFOR scale) during structured walk and transects.	Further research is required, as these indicators relate to fairly stable closed humid slack swards and not to the more open type. Other species may be included on a site specific basis (see also *Indicators of local distinctiveness*).
Vegetation composition: negative indicator species	Non-native species no more than rare. No more than one other negative indicator species more than frequent or singly or together the cover of negative indicator species no more than 5%. Negative indicator species: *Cirsium arvense, Cirsium vulgare, Cirsium palustre, Lolium perenne, Senecio jacobaea, Urtica dioica, Pteridium aquilinum, Arrhenatherum elatius*	Visual assessment of cover (modified DAFOR scale), using structured walk or transects. % cover measured is cover of the entire feature.	*Urtica dioica* and *Cirsium* spp. are indicative of poor condition Abundance of *Senecio jacobaea* indicates overgrazing in summer. *Lolium perenne* is indicative of agricultural improvement.
Vegetation composition: cover of *Salix repens*	Cover of *Salix repens* not more than 33%.	Visual assessment of cover during structured walk and transects. Aerial photographs should be used as an aid, where available.	If *Salix repens* covers more than 33% it is likely to become a problem if grazing levels are not sufficient or if scrub control is not being carried out.
Vegetation composition: scrub/trees	Scrub/trees in addition to *Salix repens* no more than occasional, or less than 5% cover.	Visual assessment of cover (modified DAFOR scale), using structured walk or transects. Aerial photographs should be used as an aid, where available.	If scrub/tree species are more than occasional throughout the sward, they are soon likely to become a problem if grazing levels are not sufficient or if scrub control is not being carried out. Where scrub or woodland is a notified habitat feature, the woodland monitoring guidance should be consulted.

***Indicators of local distinctiveness**	Maintain distinctive elements at current extent/levels and/or in current locations (e.g. maintain existing populations of notable plant or animal species or transitions between habitats).	Presence confirmed during site visit at appropriate season. (List species, add DAFOR score, mark locations on map(s) in file.) List to be tailored to each site.	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not adequately covered by the previous attributes , or by separate guidance e.g. for notified species features. For notable species (e.g. vascular plants) it is not intended to set a target for detailed species monitoring, rather to provide a rapid indication of presence/absence and/or approximate extent, allowing for natural fluctuations in population size. *If part of the reason for the notification of the site, this is a mandatory attribute. Rare or scarce plant species specific to the site may include *Epipactis palustris, Dactylorhiza incarnata, Parnassia palustris, D. purpurella, Selaginella selaginoides, Equisetum variegatum.*

Table 2.3.1 Typical species for humid dune slacks

Salix repens	*Ononis repens*	*Potentilla anserina*	*Galium palustre*	*Lotus corniculatus*
Mentha aquatica	*Lotus corniculatus*	*Hydrocotyle vulgaris*	*Campylium stellatum*	*Prunella vulgaris*
Carex flacca	*Ranunculus flammula*	*Calliergon cuspidatum*	*Equisetum variegatum*	*Anagallis tenella*
Carex arenaria				

Table 2.4 Dunes with *Salix repens*

Equivalent NVC communities: SD16 (with *Salix repens* dominant)
Annex I type: Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*) (H2170)
Phase I category: H6.4 Dune slacks

Reporting category: Supralittoral sediment

NB All attributes listed are mandatory, unless indicated as discretionary or site-specific by *. A single achieve a target leads to unfavourable condition for the whole monitoring unit.

Attributes	Targets	Methods of assessment	Comments
Extent of feature	No net loss of extent.	A baseline map should be prepared to show the distribution of the dune slacks, using aerial photography or existing NVC survey data. A comparison with the baseline should be made through maps and/or photographs, checked during the structured walk.	Give sources and dates of maps or photographs. If loss (or gain) of area is from natural causes this is not a decline in condition, but any significant loss due to human interference (e.g. sand extraction, visitor impacts, ploughing or conversion to improved grassland) is to be regarded as unfavourable. Increase in area is favourable unless related to coast protection or at the expense of other sand dune features.
Vegetation structure: condition of *Salix repens*	*Salix repens* at least frequent and 5-30cm tall.	The density and height of *Salix repens* is assessed during structured walk and transects.	
Vegetation structure: bare ground	Bare ground or sand present, but less than 10% of the total dune slack area.	Visual assessment of cover during structured walk and transects. Aerial photographs should be used as an aid, where available.	
Vegetation composition: typical species	Two or more typical species (see list at end of table) at least frequent and two or more others at least occasional.	Visual assessment of cover (modified DAFOR scale) during structured walk and transects.	Other species may be included on a site specific basis (see also *Indicators of local distinctiveness*).

Vegetation composition: negative indicator species	Non-native species no more than rare. No more than one other negative indicator species more than frequent, or singly or together the cover of negative indicator species no more than 5%. Negative indicator species: *Cirsium arvense, Cirsium vulgare, Cirsium palustre, Lolium perenne, Senecio jacobaea, Urtica dioica, Pteridium aquilinum, Arrhenatherum elatius*	Visual assessment of cover (modified DAFOR scale), using structured walk or transects. % cover measured is cover of the dune slack area.	*Urtica dioica* and *Cirsium* spp. are indicative of poor condition. Abundance of *Senecio jacobaea* indicates overgrazing in summer. *Lolium perenne* is indicative of agricultural improvement.
Vegetation composition: cover of broad-leaved grasses	Combined cover of broad-leaved grasses (*Holcus* spp., *Dactylis glomerata, Arrhenatherum elatius*) <10%.	Visual assessment of cover (modified DAFOR scale), using structured walk or transects. % cover measured is cover of the dune slack area.	*Dactylis glomerata* and *Arrhenatherum elatius* are not typical species of this community and would indicate a shift towards an ungrazed tussocky sward of MG1 grassland.
Vegetation composition: scrub/trees	Scrub/trees no more than occasional, or less than 5% cover.	Visual assessment of cover (modified DAFOR scale), using structured walk or transects. Aerial photographs should be used as an aid, where available.	If scrub/tree species are more than occasional, they are soon likely to become a problem if grazing levels are not sufficient or if scrub control is not being carried out. Where scrub or woodland is a notified habitat feature, the woodland monitoring guidance should be consulted.

***Indicators of local distinctiveness**	Maintain distinctive elements at current extent/levels and/or in current locations (e.g. maintain existing populations of notable plant or animal species or transitions between habitats).	Presence confirmed during site visit at appropriate season. (List species, add DAFOR score, mark locations on map(s) in file.) List to be tailored to each site.	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not adequately covered by the previous attributes , or by separate guidance e.g. for notified species features. For notable species (e.g. vascular plants) it is not intended to set a target for detailed species monitoring, rather to provide a rapid indication of presence/absence and/or approximate extent, allowing for natural fluctuations in population size. *If part of the reason for the notification of the site, this is a mandatory attribute. Rare or scarce plant species specific to the site may include *Equisetum variegatum, Epipactis palustris, Dactylorhiza incarnata*

Table 2.4.1 Typical species for dunes with *Salix repens*

Festuca rubra	*Carex arenaria*	*Lotus corniculatus*	*Euphrasia officinalis*
Carex flacca	*Ononis repens*	*Pilosella officinarum*	

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Table 1. UK GUIDANCE ON CONSERVATION OBJECTIVES FOR MONITORING DESIGNATED SITES

Interest feature: **Saltmarsh**

Includes the following:

Pioneer saltmarsh: Equivalent NVC communities: SM4, SM5, SM6, SM7, SM8, SM9, SM11, SM12.
Annex I types: *Salicornia* and other annuals colonising mud and sand (1310), *Spartina* swards (1320)
Low-mid marsh communities: Equivalent NVC communities: SM10, SM13a, SM14.
Annex I types: Atlantic saltmeadows (1330) *pp.*
Mid-upper marsh communities: Equivalent NVC communities: SM13b,c,d, SM15, SM16, SM17, SM18, SM19, SM20, SM21, SM22, SM23, SM26, SM27
Annex I types: Atlantic saltmeadows (1330) *pp*, Mediterranean and thermo-Atlantic halophilous scrubs (1420).
Driftline: Equivalent NVC communities: SM24 and SM25, SM28
Annex I types: Atlantic saltmeadows (1330) *pp*
Transitions: including mesotrophic grassland communities (e.g. MG 11, MG12, MG13) brackish mire (M28) and swamp communities (e.g. S4, S5, S18, S19, S20, S21, S26)

Phase I category: H2 Saltmarsh

Reporting category: **Littoral sediment**

NB All attributes listed are mandatory, unless indicated as discretionary. A single failure to achieve a target among the mandatory attributes leads to unfavourable condition for the whole monitoring unit

Attribute	Targets	Method of assessment	Comments
Extent of habitat	No decrease in extent from the established baseline, subject to natural change.	A baseline map should be prepared to show the distribution of saltmarsh vegetation, using aerial photography or existing NVC survey data. **See extent key in 5**	See guidance on habitat extent, patterns of saltmarsh erosion, effects of sea level rise (Section 4). Extent may be subject to periodic and seasonal variation, particularly pioneer saltmarsh. Extent should be measured at low tide.
Physical structure: creeks and pans	No further anthropogenic alteration of creek patterns or loss of pans compared to an established baseline. Realignment of creeks absent or rare.	Aerial photographs can be used, combined with information gathered from the site visit.	Creeks and pans vary in size and density. Creeks absorb tidal energy and assist with the delivery of sediment into saltmarshes. Major erosion of saltmarsh is indicated by internal dissection and enlargement of the drainage network, ultimately leading to the creation of mud basins.

Attribute	Targets	Method of assessment	Comments
Vegetation structure: zonation of vegetation	Maintain the range of variation of zonations typical of the site. See lists of indicators (Box 1) and notes on transitional vegetation below.	The width of zones can be estimated using one or more transects extending from strand to lowest continuous marsh. The GPS information can be collected and marked on a map.	The pattern of saltmarsh zonation will vary regionally and also from site to site (see Section 6.1). Saltmarsh has up to five main zones: pioneer, low-mid marsh, mid-upper marsh, saltmarsh strand plus transitions (see transitions below)
Vegetation structure: sward height	Maintain site-specific structural variation in the sward. (see section 6.2) Example: Strangford Lough: Maintain short sward (4 – 12 cm) in areas of species-rich vegetation	This can be assessed by taking average sward height from the quadrats forming part of the structured walk	Stocking levels need to be appropriate to the interest of the site (see Section 6.2). Over-grazing can lead to loss of rare plant species and affect bird breeding and feeding habitats and under-grazing can lead to a loss of plant diversity by competitive exclusion. A varied vegetation structure is important for maintaining invertebrate diversity.
Vegetation composition: characteristic species	Maintain frequency of characteristic species of saltmarsh zones (see Box 1 below) as follows: Pioneer zone: At least one listed species frequent and another occasional Low-mid marsh: At least one of *Puccinellia maritima, Atriplex portulacoides* or *Salicornia* spp. dominant., and two other listed species at least frequent Mid-upper marsh: At least one listed species abundant and three frequent Terrestrial transition: where present appropriate targets should be set, with reference to relevant guidance section e.g. Lowland grassland, lowland wetland (see 7.1)	Visual assessment of cover, using structured walk	Communities may be dynamic in their distribution and are linked to the physical processes operating at the site, including topography, creek patterns etc. The species composition and type of saltmarsh will vary regionally and also from site to site (see also text on zonation). A variety of communities may occur at the transition zone at the top of the salt marsh. These include mesotrophic grassland communities (e.g. MG11 - MG13) together with swamp communities (e.g. S4, S12, S20, S21 & S28). In addition stands of tall fen community with *Filipendula ulmaria* and *Iris pseudacorus* (M28) can locally be prominent.
Vegetation composition: negative indicator species *Spartina anglica*	No recent evidence of expansion into pioneer saltmarsh (indicative target of less than 10 % expansion in last 10 years)	Aerial photographs, together with visual assessment of cover, using structured walk	*Spartina anglica* is a species that is considered undesirable in intertidal habitats where it is expanding at the expense of mudflats (seeSection 7.2). However it can be a precursor to the development of saltmarsh where sediments are accreting. Natural die-back has occurred in some areas.

Attribute	Targets	Method of assessment	Comments
Other negative indicators	Artificial drainage channels adversely affecting hydrology are absent or rare No obvious signs of pollution. Turf cutting absent or rare No increase in bare substrate as a result of anthropogenic activities such as vehicle use or trampling at vulnerable locations (tracks, access points) Poaching damage from stock or horses rare, with bare mud extent <25%	Visual assessment during site visit	
Indicators of local distinctiveness* *If part of the reason for the notification of the site, this is a mandatory attribute	Maintain distinctive elements at current extent/levels and/or in current locations (e.g. maintain existing populations of notable species, important structural attributes or notable transitions between habitats).	Presence confirmed during visit at appropriate season (list species, add DAFOR score, mark locations on map(s) in file). List to be tailored to each site	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not adequately covered by the previous attributes , or by separate guidance e.g. for notified species features.

Box 1. Typical species for saltmarsh zones

pioneer zone	low-mid marsh	mid-upper marsh	
Salicornia spp.	*Puccinellia maritima*	*Festuca rubra*	*Artemisia maritima*
Suaeda maritima	*Triglochin maritima*	*Juncus gerardii*	*Leontodon autumnalis*
Puccinellia maritima	*Plantago maritima*	*Armeria maritima*	*Carex flacca*
Aster tripolium	*Atriplex portulacoides*	*Agrostis stolonifera*	*Carex extensa*
	Aster tripolium	*Limonium vulgare*	turf fucoids
	Spergularia maritima	*Glaux maritima*	
	Suaeda maritima	*Seriphidium maritimum*	
	Salicornia spp.	*Plantago maritima*	
	turf fucoids	*Aster tripolium*	
		Juncus maritimus	
		Triglochin maritima	
		Blysmus rufus	
		Eleocharis uniglumis	

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Table 2. UK guidance on conservation objectives for monitoring designated sites

Interest feature: Shingle

Includes the following NVC types. The NVC does not cover the whole range of shingle vegetation, only the pioneer phases have a specific NVC classification: SD1, SD2, SD3, MC6. A full list of NVC equivalents is provided in the Coastal Vegetated Shingle Structures of Great Britain (Sneddon and Randall 1993) and this includes pioneer, lichen/moss communities, heathland, grassland, wetland and scrub.

Annex I habitats:
Annual vegetation of drift lines (H1210) which includes the following NVC types: SD2 *Cakile maritima–Honkenya peploides* strandline community and the SD3 *Matricaria maritima-Galium aparine* strandline community. MC6 *Atriplex prostrata – Beta vulgaris* ssp. *maritima* sea-bird cliff community may also be present and other vegetation types not described in the NVC, e.g. monospecific stands of *Atriplex* spp.
Perennial vegetation of stony banks (H1220) which includes the NVC type SD1 *Rumex crispus-Glaucium flavum* shingle community and a wide range of other vegetation types (see section 2).

Transitions: including saltmarsh communities (e.g. SM13, SM28) brackish mire (M28), swamp communities (e.g. S4, S5, S19, S20, S21), grassland (e.g. MG1, MG11) heathland (e.g. H1, H11)

Phase I category: H3 Shingle/gravel above high-tide mark

Reporting category: Supralittoral sediment

All attributes are mandatory unless indicated by * (one failure among mandatory attributes = unfavourable condition)

Attribute	Targets	Method of assessment	Comments
Habitat extent	No decrease in extent from the established baseline subject to natural change **(see text on habitat extent, section 8)**	A baseline map should be prepared to show the distribution of shingle vegetation, using aerial photography or existing NVC survey data Aerial photography/other remote sensing can help with assessing shingle structure and perennial vegetation, but may not pick up driftline vegetation.	Extent may be subject to periodic and seasonal variation, and will need to be assessed over a period of time Natural processes may result in re-distribution of shingle sediments and changes in sediment composition. Such changes are usually acceptable.

Attribute	Targets	Method of assessment	Comments
Physical structure: functionality and sediment supply	No increase in linear constraints to mobility in active foreshore zone e.g. introduced structures, or active shingle management such as beach recycling for coastal defence	Aerial photographs can be used combined with information gathered from the site visit	An important aspect of this habitat is the ability to respond to natural coastal processes, which may result in changes in extent and distribution of the substrate that can subsequently be colonised by pioneer species. Ensure that natural processes govern system
Vegetation structure: zonation of vegetation	Maintain the range of vegetation zones and transitions typical of the site	Transects extending from beach to stable vegetated shingle can be used to estimate the width of the driftline and perennial vegetation zones at points described by GPS and marked on a map.	Individual sites will have different patterns of vegetation types depending on site size, history, substrate and patterns of human use. Perennial vegetation of the shingle feature may include grassland, heathland and scrub depending on the exact nature of the site.
Vegetation composition: positive indicators	Maintain frequency of characteristic species of the vegetated shingle zones (see Box 1 below) as follows **annual vegetation of drift lines (strandline)**: At least one listed species frequent and another occasional **perennial vegetation of stony banks (SD1)**: At least two listed species abundant and two frequent Lists to be tailored to each site. For other vegetation types appropriate targets should be set with reference to relevant guidance sections e.g. Lowland grassland, lowland heath, sand dune (see section 11)	Visual assessment using structured walk	Because of the variability of shingle habitats it is not feasible to give comprehensive guidance. Species and targets should be set for key vegetation units on a site-specific basis, taking account of the specific conditions and vegetation characteristics. Where appropriate, targets should be based on related habitat guidance. See section 11 for further comments.

Attribute	Targets	Method of assessment	Comments
Vegetation composition: negative indicators	Target should be set to register high or increasing frequency/cover as unfavourable for species not typically associated with communities that define the feature (i.e. undesirable 'weed' species, species uncharacteristic of typical shingle communities or non-native invasive species). For vegetation types such as dry acid grasslands and dwarf-shrub heath on shingle, appropriate targets should be set with reference to relevant guidance sections e.g. Lowland grassland, lowland heath (see section 13)	Aerial photographs, together with visual assessment of cover, using structured walk	Negative species will include non-native species (e.g. *Lupinus arboreus*, *Centranthus ruber*, *Tamarix gallica*), invasive species indicative of changes in nutrient status (e.g. *Senecio jacobaea*, *Cirsium vulgare*) and species not characteristic of typical communities (e.g. *Pteridium aquilinum*).
Other negative indicators: signs of disturbance	No loss of vegetated substrate within the habitat as a result of anthropogenic activities	Visual assessment of disturbance such as vehicle damage or trampling at vulnerable locations (tracks, access points) during site visit	Where recycling schemes have been consented these should comply with conditions of the licence. It is possible that despite licence conditions damage to the has site occurred, which needs to be considered at licence renewal
Indicators of local distinctiveness* **(including notable species and transitions to other terrestrial or wetland habitats)** *If part of the reason for the notification of the site these are a mandatory attribute	Targets to be set to maintain distinctive elements at current extent/levels and/or in current locations, e.g. to maintain existing populations of notable species or transitions between habitats. Targets for the transition areas should be set according to the scientific citation, local distinctiveness or the management plan.	The presence of indicators of local distinctiveness to be confirmed during visit at appropriate season (list species, add DAFOR score, mark locations on map(s) in file. List to be tailored to each site	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not adequately covered by the previous attributes , or by separate guidance e.g. for notified species features. A variety of terrestrial habitat types, such as heathland, grasslands etc. may be part of the vegetated shingle feature. However, transitions to other habitats such as saltmarsh, sand dune, M28 *Iris pseudacorus* mire or other wetland types may be present (see Table 1).

Box 1. Typical spp. for vegetated shingle zones (see also Sneddon & Randall 1993)

Annual vegetation of drift lines	Perennial vegetation of stony banks
Honckenya peploides, *Cakile maritima*, *Atriplex prostrata*, *A. glabriuscula*, *A. laciniata*, *Salsola kali*, *Galium aparine*, *Matricaria maritima*, *Polygonum oxyspermum*.	*Rumex crispus*, *Crambe maritima*, *Glaucium flavum*, *Silene uniflora*, *Beta vulgaris maritima*, *Lathyrus japonicus*, *Picris echioides*

APPENDIX 4

Common Standards Monitoring

Lowland Grassland Habitats (JNCC 2004b)

Table 2a. Examples of positive indicator species for each community: lowland meadows and upland hay meadows

Table 3a. Examples of positive indicator species for each community: lowland dry acid grassland

Table 4a. Examples of positive indicator species for each community: lowland calcareous grasslands

Table 5a. Examples of positive indicator species for each community: lowland purple moor grass and rush pastures

Table 2a. Examples of positive indicator species for each community: lowland meadows and upland hay meadows

MG3	MG4	MG5	MG8
Alchemilla spp., *Anemone nemorosa, Centaurea nigra, Cirsium heterophyllum, Conopodium majus, Euphrasia* spp., *Filipendula ulmaria, Geranium sylvaticum, Geum rivale, Lathyrus pratensis, Leontodon* spp., *Lotus corniculatus, Persicaria bistorta, Rhinanthus minor, Sanguisorba officinalis, Succisa pratensis, Trollius europaeus.*	*Centaurea nigra, Filipendula ulmaria, Galium verum, Leontodon hispidus, Lotus corniculatus, Oenanthe silaifolia, Persicaria bistorta, Primula veris, Rhinanthus minor, Sanguisorba officinalis, Serratula tinctoria, Silaum silaus, Stachys officinalis, Succisa pratensis, Thalictrum flavum*	*Agrimonia eupatoria, Alchemilla* spp., *Anemone nemorosa, Centaurea nigra, Filipendula vulgaris, Galium verum, Genista tinctoria, Lathyrus linifolius, Leontodon hispidus, L. saxatilis, Lotus corniculatus, Pimpinella saxifraga, Polygala* spp., *Potentilla erecta, Primula veris, Sanguisorba minor, S. officinalis, Serratula tinctoria, Silaum silaus, Stachys officinalis, Succisa pratensis*	*Berula erecta, Caltha palustris, Cirsium dissectum, Eupatorium cannabinum, Filipendula ulmaria, Galium palustre, G. uliginosum, Geum rivale, Hydrocotyle vulgaris, Lotus pedunculatus, Lychnis flos-cuculi, Mentha aquatica,* Orchidaceae spp., *Potentilla palustris, Ranunculus flammula, Succisa pratensis, Thalictrum flavum, Valeriana dioica, Viola palustris*

Table 3a. Examples of positive indicator species for each community: lowland dry acid grasslands

U1	U3	U4
Aira spp., *Aphanes* spp., *Astragalus danicus, Campanula rotundifolia, Centaurium erythraea Cetraria spp., Cladonia* spp., *Erodium circutarium, Galium saxatile, G. verum, Lotus corniculatus, Ornithopus perpusillus, Pilosella officinarum, Plantago coronopus, Potentilla erecta, Rumex acetosella, Sedum acre, S. anglicum, Thymus* spp.	*Agrostis curtisii, Calluna vulgaris, Cladonia* spp., *Erica cinerea, E. tetralix, Galium saxatile, Polygala* spp., *Potentilla erecta, Vaccinium myrtillus*	*Anemone nemorosa, Calluna vulgaris, Campanula rotundifolia, Erica cinerea, E. tetralix, Galium saxatile, G. verum, Genista tinctoria, Lathyrus linifolius, Leontodon taraxacoides, Lotus corniculatus,* Orchidaceae spp., *Pedicularis sylvatica, Pilosella officinarum, Pimpinella saxifraga, Polygala* spp., *Potentilla erecta, Rumex acetosella, Sanguisorba officinalis, Serratula tinctoria, Stachys officinalis, Succisa pratensis, Vaccinium myrtillus, Veronica officinalis, Vicia orobus, Viola* spp.

Table 4a. Examples of positive indicator species for each community: lowland calcareous grasslands

CG1	CG2	CG3, CG4, CG5	CG6
Acinos arvensis, Anthyllis vulneraria, Carex spp., *Carlina vulgaris, Helianthemum* spp., *Leontodon hispidus, L. saxatilis, Lotus corniculatus, Pilosella officinarum, Sanguisorba minor, Scabiosa columbaria, Scilla* spp., *Thymus* spp., *Trinia glauca.*	*Anthyllis vulneraria, Asperula cynanchica, Campanula glomerata, Carex* spp., *Centaurea nigra, Cirsium acaule, Filipendula vulgaris, Helianthemum* spp., *Hippocrepis comosa, Leontodon hispidus, L. saxatilis, Lotus corniculatus, Pilosella officinarum, Polygala* spp., *Potentilla erecta, Primula veris, Sanguisorba minor, Scabiosa columbaria, Serratula*	*Anthyllis vulneraria, Asperula cynanchica, Campanula glomerata, Carex flacca, Cirsium acaule, Filipendula vulgaris, Galium verum, Helianthemum nummularium, Hippocrepis comosa, Leontodon hispidus, L. saxatilis, Lotus corniculatus, Pilosella officinarum, Polygala spp., Primula veris, Sanguisorba minor, Scabiosa*	*Agrimonia eupatoria, Anthyllis vulneraria, Carex flacca, Centaurea nigra, Centaurea scabiosa, Clinopodium vulgare, Filipendula vulgaris, Geranium sanguineum, Helianthemum nummularium,*
	tinctoria, Stachys officinalis, Succisa pratensis, Thymus spp.	*columbaria, Succisa pratensis, Thymus* spp.	*Hypericum* spp., *Knautia arvensis, Leontodon hispidus, Lotus corniculatus,* Orchidaceae spp., *Origanum vulgare, Pimpinella* spp., *Primula veris, Sanguisorba minor, Thalictrum minus, Thymus* spp.

CG7	CG8	CG9	MG2
Aira spp., *Aphanes* spp., *Astragalus danicus, Campanula rotundifolia, Carex* spp., *Centaurium erythraea, Cetraria spp., Cladonia* spp., *Dianthus deltoides, Erigeron acer, Erodium cicutarium, Fragaria vesca, Galium saxatile, G. verum, Helianthemum nummularium, Leontodon hispidus, L. saxatilis, Lotus corniculatus, Ornithopus perpusillus, Pilosella officinarum, Plantago coronopus, Potentilla erecta, Rumex acetosella, Sedum acre, S. anglicum, Teesdalia nudicaulis, Thymus* spp.	*Sesleria caerulea, Anthyllis vulneraria, Galium verum, Gentianella* spp., *Helianthemum nummularium, Hypericum pulchrum, Linum catharticum, Listera ovata, Lotus corniculatus, Pimpinella saxifraga, Plantago media, Polygala* spp., *Primula veris, Sanguisorba minor, Scabiosa columbaria, Stachys officinalis, Succisa pratensis, Thymus polytrichus, Viola hirta.*	*Antennaria dioica, Armeria maritima, Asperula cynanchica, Carlina vulgaris, Campanula rotundifolia, Cochlearia pyrenaica, Draba incana, Dryas octopetala, Euphrasia* spp., *Filipendula vulgaris, Galium sterneri, Gentiana verna, Gentianella* spp., *Helianthemum oelandicum, H. nummularium, Hippocrepis comosa, Leontodon hispidus, Lotus corniculatus, Myosotis alpestris, Parnassia palustris, Persicaria vivipara, Pilosella officinarum, Pinguicula vulgaris, Plantago maritima, Primula farinosa, Sanguisorba minor, Saxifraga hypnoides, Scabiosa columbaria, Selaginella selaginoides, Succisa pratensis, Thymus polytrichus*	*Alchemilla* spp., *Angelica sylvestris, Centaurea nigra, Cirsium heterophyllum,* Fern spp. excluding bracken, *Filipendula ulmaria, Galium verum, Geranium sylvaticum, Geum rivale, Mercurialis perennis, Polemonium caeruleum, Sanguisorba officinalis, Succisa pratensis, Valeriana officinalis*

Table 5a. Examples of positive indicator species for each community: lowland purple moor grass and rush pastures

M22	M23	M24	M25	M26
Caltha palustris, Centaurea nigra, Eupatorium cannabinum, Filipendula ulmaria, Galium palustre, G.uliginosum, Hydrocotyle vulgaris, Lotus pedunculatus, Lychnis flos-cuculi, Lythrum salicaria, Mentha aquatica, Orchidaceae spp., *Pedicularis* sp., *Potentilla palustris, Succisa pratensis, Thalictrum flavum, Valeriana dioica*	*Achillea ptarmica, Caltha palustris, Carum verticillatum, Filipendula ulmaria, Galium palustre, Hydrocotyle vulgaris, Lotus pedunculatus, Lychnis flos-cuculi, Lythrum salicaria, Mentha aquatica,* Orchidaceae spp., *Viola palustris.*	*Anagallis tenella, Angelica sylvestris, Calluna vulgaris, Carum verticillatum, Centaurea nigra, Cirsium dissectum, Erica tetralix, Eupatorium cannabinum, Filipendula ulmaria, Galium uliginosum, Narthecium ossifragum,* Orchidaceae spp., *Pedicularis sylvatica, Potentilla erecta, Salix repens, Serratula tinctoria, Sphagnum* spp., *Succisa pratensis, Valeriana dioica*	*Angelica sylvestris, Calluna vulgaris, Carum verticillatum, Centaurea nigra, Erica tetralix, Eupatorium cannabinum, Filipendula ulmaria, Mentha aquatica, Narthecium ossifragum,* Orchidaceae spp., *Pedicularis sylvatica, Potentilla erecta, Serratula tinctoria, Sphagnum* spp., *Succisa pratensis, Viola palustris, Valeriana dioica, V. officinalis*	*Angelica sylvestris, Caltha palustris, Crepis paludosa, Filipendula ulmaria, Geum rivale, Leontodon hispidus, Lychnis flos-cuculi,* Orchidaceae spp., *Potentilla erecta, Sanguisorba officinalis, Serratula tinctoria, Succisa pratensis, Trollius europaeus, Valeriana dioica*

APPENDIX 5

Common Standards Monitoring

Lowland Wetland Habitats (JNCC 2004c)

Table 5. Desirable species for key NVC communities of lowland fens

Table 6. Undesirable species for key NVC communities in lowland fens

Table 5 **Desirable species for key NVC communities of lowland fens** (see Table 4). The targets and species listed are for guidance and it may be appropriate to substitute other species or adjust thresholds in some situations. Targets may also be combined for mixtures of NVC types. Further guidance may be sought from country agency wetland specialists. Frequency classes for species should be as follows: 1-20% rare, 21-40% occasional, 41-60% frequent, >60% constant. Frequency is defined as the chance of finding a species at a point positioned at random in a stand. Cover is dealt with separately.

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
M4	**Basin fen**: base-poor sump wetland **Valley fen**: soakway/water track **Springs & flushes**: *Sphagnum* dominated acid flushes	*Carex rostrata, C. lasiocarpa*: either or both, combined cover >10% *Sphagnum cuspidatum, S. fallax, S. denticulatum*: individually or together combined cover >50% Associated species *Potentilla erecta, Galium palustre, Rumex acetosa, Viola palustris, Stellaria uliginosa*: at least 2 species at least occasional	The whole should form a floating raft of sphagna and sedges. The list of associated species needs to be defined locally.
M5	**Flood-plain fen**: base-poor sump wetland **Valley fen**: base-poor sump wetland	*Carex rostrata, C. lasiocarpa, C. nigra, Eriophorum angustifolium*: combined cover >10% *Sphagnum subnitens, S. squarrosum, S. teres, S. palustre, S. fallax, Aulacomnium palustre*: individually or together combined cover >25% Associated species *Potentilla palustris, Menyanthes trifoliata, Galium palustre, Succisa pratensis ,Viola palustris ,Ranunculus flammula, Epilobium palustre, Lychnis flos-cuculi*: at least 4 species constant	The whole should form a floating raft of sphagna and sedges. The list of associated species needs to be defined locally and may in some areas include acidophiles such as *Vaccinium oxycoccos*.
M6	**Basin fen**: base-poor sump wetland and spring-fed wetland **Valley fen**: run-off wetland **Springs & flushes**: *Sphagnum* dominated acid flushes	*Carex echinata*: cover >10% *Carex panicea, C. nigra, C. viridula* ssp. *oedocarpa*: at least one species present *Sphagnum fallax, S. denticulatum, S. palustre*: at least 2 present; combined cover >30% Associated species *Viola palustris, Potentilla erecta, Galium saxatile, G. palustre, Cirsium palustre, Epilobium palustre, Succisa pratensis, Ranunculus*	*Juncus effusus* and/or *J. acutiflorus* will be dominant in their respective sub-communities. The sphagna form a matrix between the sedges and rushes. The list of associated species needs to be defined locally.

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
		flammula, Cardamine pratensis: at least 3 constant	
M9	**Flood-plain fen**: base-poor and base-rich sump wetland, percolating wetland **Basin fen**: base-rich sump wetland and percolating wetland **Valley fen**: base-poor and base-rich sump wetland, percolating wetland	*Carex diandra, C. lasiocarpa, C. rostrata, C. limosa, C. panicea, C. nigra, Eriophorum angustifolium*: at least 2 constant, one of which must be *C. diandra, C. lasiocarpa or C. rostrata* *Calliergonella cuspidata, Calliergon giganteum*: either or both, combined cover >20% *Campylium stellatum, Scorpidium scorpioides, Drepanocladus revolvens, Bryum pseudotriquetrum, Palustriella commutata, Cratoneuron filicinum, Ctenidium molluscum*: at least one species present Associated species *Menyanthes trifoliata, Mentha aquatica, Pedicularis palustris, Epilobium palustre, Potentilla palustris, Cardamine pratensis, Potamogeton* spp. *Caltha palustris*: at least 3 locally characteristic species constant	For the purposes of identification, *Carex diandra* and *C. lasiocarpa* can be lumped together as 'fine-leaved sedges'. A prominent bryophyte carpet is a feature of all but the very wettest stands.
M10	**Flood-plain fen**: percolating wetland **Basin fen**: base-rich spring-fed wetland and percolating wetland **Valley fen**: base-rich spring-fed wetland and percolating wetland	*Carex hostiana, C. dioica, C. viridula* (all ssp.), *C. flacca, C. panicea*: at least 2 species or subspecies constant	A highly variable vegetation type, additional local targets may be necessary to reflect the richness of particular sites
M13	**Flood-plain fen**: percolating wetland **Basin fen**: base-rich spring-fed wetland and percolating wetland **Valley fen**: base-rich spring-	*Schoenus nigricans* constant, cover <80% in at least 40% of samples. *Carex hostiana, C. dioica, C. viridula* (all ssp.), *C. flacca, C. panicea*: at least 2 species or subspecies constant	Very high cover of *Schoenus* may indicate lack of grazing.

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
	fed wetland and percolating wetland		
M14	**Flood-plain fen**: percolating wetland **Basin fen**: base-rich spring-fed wetland and percolating wetland **Valley fen**: base-poor spring-fed wetland and percolating wetland	*Schoenus nigricans, Molinia caerulea*: tussock cover between 10% and 70% with *Schoenus* predominating *Sphagnum subnitens, S. denticulatum, Campylium stellatum, Aneura pinguis, Scorpidium scorpioides*: at least one *Sphagnum* and one 'brown' moss constant, combined cover >20% Associated species *Narthecium ossifragum, Anagallis tenella, Drosera rotundifolia, Eriophorum angustifolium, Rhynchospora alba, Eleocharis multicaulis, Erica tetralix*: at least 3 species constant	Both *Schoenus* and *Molinia* are likely to be present, but *Molinia* should not increase at the expense of *Schoenus*.
M18	**Basin fen**: ombrogenous nuclei (topogenous bog) **Valley fen**: ombrogenous nuclei (topogenous bog)	Use the vascular plant and bryophyte positive indicators given in Table 3 Lowland raised bog.	
M21	**Valley fen**: base-poor spring-fed wetland **Basin fen**: base-poor sump wetland and spring-fed wetland	*Sphagnum papillosum* and/or *S. magellanicum*: cover >70% in 80% of samples *Sphagnum denticulatum, S. cuspidatum,, S. fallax, Odontoschisma sphagni*: at least one species at least occasional Associated species *Calluna vulgaris, Drosera rotundifolia, Erica tetralix, Eriophorum angustifolium, Molinia caerulea, Narthecium ossifragum, Rhynchospora alba, Vaccinium oxycoccos*: at least 3 species constant	The cover attribute is vital. To pick up the other sphagna it is necessary to sample over the whole area occupied by the community; there is geographical and zonal variability. The associated species vary with the sub-community and will be site-specific.
M22	**Valley fen**: base-rich spring-fed wetland **Fen meadows**	In most instances this component will not need to be monitored for positive indicators. When it appears from the citation that it is an important component of the wetland feature, targets for positive indicators should be selected from the lowland grassland guidance	

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
		chapter. When it is a feature in its own right, the lowland grassland guidance should be used.	
M25	**Valley fen**: run-off wetland **Fen meadows**	In most instances this component will not need to be monitored for positive indicators. When it appears from the citation that it is an important component of the wetland feature, targets for positive indicators should be selected from the lowland grassland guidance chapter. When it is a feature in its own right, the lowland grassland guidance should be used.	
M27	**Flood-plain fen**: alluvial wetland	*Filipendula ulmaria*: constant *Angelica sylvestris*, *Valeriana officinalis*, *Rumex acetosa*, other locally abundant dominants: at least 3 species constant *Valeriana officinalis-Rumex acetosa* sub-community: *Lychnis flos-cuculi*, *Succisa pratensis*, *Geum rivale*, *Galium palustre*, *Urtica dioica*: at least 2 species at least frequent *Urtica dioica-Vicia cracca* sub-community: *Urtica dioica, Epilobium hirsutum, Eupatorium cannabinum, Vicia cracca*: at least 2 species at least frequent *Juncus effusus-Holcus lanatus* sub-community: *Juncus effusus, Holcus lanatus*: both species constant	This is a very heterogeneous community and examples will vary locally. Towards the west, *Iris pseudacorus* and *Oenanthe crocata* become prominent, and compositionally close to M28. Regular grazing is detrimental to the species assemblage (and also its structure for invertebrates), though sporadic grazing or other type of litter removal is necessary for plant species diversity.
M28	**Flood-plain fen**: alluvial wetland	*Filipendula ulmaria, Iris pseudacorus, Oenanthe crocata, Poa trivialis*: at least two spp. constant. *Lycopus europaeus, Rumex crispus, Scutellaria galericulata*: at least one sp. constant. *Juncus effusus-Juncus acutiflorus* sub-community: *Juncus effusus, Juncus acutiflorus, Rumex acetosa, Ranunculus acris*: at	This is a very heterogeneous community and examples will vary locally. It merges eastwards with M27 from its western stronghold. It is a focus for *Lythrum salicaria* and *Stachys palustris*. Many

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
		least 2 spp. at least frequent. *Urtica dioica-Galium aparine* sub-community: *Urtica dioica, Galium aparine, Cirsium arvense*: at least 2 spp. at least frequent. *Atriplex prostrata-Samolus valerandii* sub-community: *Atriplex prostrata* and *Samolus valerandi* both at least frequent.	other plants may be locally abundant and dominant, such as *Rumex acetosa, Lychnis flos-cuculi, Angelica sylvestris, Valeriana officinalis* and *Urtica dioica*. Regular grazing is detrimental to the species assemblage (and also its structure for invertebrates), though sporadic grazing or other type of litter removal are necessary for plant species diversity. The community is dependent on nutrient-rich water, and those species indicative of enrichment are expected. It merges with saline communities, via the *Atriplex -Samolus* sub-community.
M29	**Flood-plain fen**: soakway/water track **Valley fen**: soakway/water track and percolating wetland	*Hypericum elodes, Potamogeton polygonifolius*: combined cover >50% with neither species less than 5% cover *Ranunculus flammula, Juncus bulbosus*: both species present, combined cover <10% Associated species *Hydrocotyle vulgaris, Anagallis tenella, Drosera rotundifolia, Narthecium ossifragum, Galium palustre, Carex viridula* ssp.	Each site will have its own list of low cover associated species. For 'Depressions in peat substrates (Rhynchosporion)', *Rhynchospora alba* cover must be >1%.

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
		oedocarpa, C. echinata, C. panicea, C. nigra, Rhynchospora alba: at least 3 species present, combined cover <10%	
M32, M35, M36	**Springs & flushes**: neutral flushes	*Ranunculus omiophyllus, Montia fontana, Saxifraga stellaris*: at least one species present *Agrostis stolonifera, Saxifraga stellaris*: at least one species at least frequent *Sphagnum denticulatum, Philonotis fontana*: both species present with a combined cover >50%	
M37	**Springs & flushes**: Petrifying springs with tufa formation (Cratoneurion)	*Festuca rubra, Carex nigra, C. panicea, Cardamine pratensis, Leontodon autumnalis*: at least one species present *Saxifraga aizoides, Carex viridula, C. panicea, C. nigra, C. dioica, Agrostis stolonifera, A. canina, Deschampsia cespitosa, Equisetum palustre, Epilobium alsinifolium, Chrysosplenium oppositifolium, Poa trivalis, Trifolium repens*: at least one species at least frequent *Bryum pseudotriquetrum, Palustriella commutata* and/or *Cratoneuron filicinum, Selaginella selaginoides, Philonotis fontana*: at least 2 species present with a combined cover >50%	Tufa-type springs in the lowlands may have a rather different species composition and other species with similar ecological characteristics may be more appropriate indicators at some sites
S1	**Flood-plain fen**: base-rich sump and percolating wetlands **Basin fen**: percolating wetland **Open water transition fen** **Valley fen**: base-rich sump wetland	*Carex elata*: dense tussocks constant, cover >40% Associated species *Ranunculus lingua, Cirsium palustre, Eupatorium cannabinum, Lycopus europaeus*: at least 2 species present	The list of associated species needs to be defined locally.
S2	**Flood-plain fen**: alluvial, base-rich sump and percolating wetland **Basin fen**: base-rich sump and percolating wetland **Open water transition fen** **Valley fen**: base-rich sump	*Cladium* sub-commmunity: *Cladium mariscus*: constant in dense stands *Menyanthes trifoliata* sub-community: *Cladium mariscus*: open stands, less than 1m tall, with pools of open water *Menyanthes trifoliata, Potentilla palustris, Carex lasiocarpa,*	The *Menyanthes* sub-community is more valuable than the *Cladium* sub-community, and this should be reflected in target setting for the site. The *Menyanthes* sub-community may be

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
	wetland and percolating wetland	*Scorpidium scorpioides, Utricularia vulgaris, Phragmites australis, Juncus subnodulosus*: at least 3 species present, combined cover <50% with *Phragmites* <20% cover	placed within 'Cladium fen with species of the Caricion davallianae'.
S3	**Flood-plain fen**: base-poor and base-rich sump wetland **Open water transition fen Valley fen**: base-poor and base-rich sump wetlands	*Carex paniculata*: healthy tussocks with bare peat or water between, plus a few scattered associates (e.g. *Angelica sylvestris, Filipendula ulmaria, Galium palustre, Rubus fruticosus, Solanum dulcamara*) between and as epiphytes	The associated species will be site-specific and reflect adjoining communities.
S4	**Open water transition fen**	*Phragmites australis* sub-community: *Phragmites australis* forming a closed or open stand; >90% cover Associated species e.g. *Typha latifolia, T. angustifolia, Carex riparia, Cladium mariscus, Berula erecta*: can be locally prominent, but should be about 5% cover overall *Galium palustre* sub-community: *Phragmites australis* forming a closed or open stand; >70% cover Associated species e.g. *Galium palustre,, Mentha aquatica, Lythrum salicaria, Iris pseudacorus*: can be locally prominent, but should be about 10% cover overall *Menyanthes trifoliata* sub-community: *Phragmites australis* forming a closed or open stand; >50% cover Associated species e.g. *Menyanthes trifoliata, Equisetum fluviatile, Carex rostrata, Potentilla palustris*: can be locally prominent, but should be about 10% cover overall *Atriplex prostrata* sub-community: *Phragmites australis* forming a closed or open stand; > 80% cover	The reedbed may be important for birds and invertebrates. It is important to set targets which reflect the structure required for e.g. bitterns, sedge and reed warblers, bearded reedlings and various moths. Targets should also reflect the greater value of the more species-rich sub-communities. The *Atriplex* sub-community is a brackish water transition sub-community.
S5	**Flood-plain fen**: alluvial wetland	*Glyceria maxima* sub-community: *Glyceria maxima*: constant	Both of these sub-communities are of low

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
		Associated species e.g. *Lemna minor, Solanum dulcamara*: at least 2 species present *Alisma plantago-aquatica, Sparganium erectum* sub-community: *Glyceria maxima*: patchy and fragmentary stands not total cover Associated species e.g. *Alisma plantago-aquatica, Sparganium erectum, Rorippa nasturtium-aquaticum*: at least one species forming a patchy understorey	plant species richness, although the *Alisma-Sparganium* sub-community is slightly richer. Any value is more likely to lie in the invertebrates.
S6	**Flood-plain fen**: alluvial and base-rich sump wetland **Open water transition fen** **Valley fen**: base-rich sump wetland	*Carex riparia*: cover >70% Associated species *Phragmites australis, Equisetum fluviatile, E. palustre, Phalaris arundinacea, Epilobium hirsutum, Filipendula ulmaria*: at least 2 species present, combined cover <30%	
S8	**Flood-plain fen**: alluvial wetland **Open water transition fen**	*Scirpus lacustris* ssp. *lacustris* (*Schoenoplectus lacustris*) sub-community: *Schoenoplectus lacustris*: open, can share up to 50% cover with *Phragmites* and grow up to 3m tall. *Sparganium erectum* sub-community: *Schoenoplectus lacustris*: <2m in height *Sparganium erectum*: present *Equisetum fluviatile* sub-community: *Schoenoplectus lacustris*: <2m in height Associated species e.g. *Equisetum fluviatile, Carex rostrata, Menyanthes trifoliata*: at least one species present, combined cover <50%	A wide variety of other aquatic and fen species can occur. The *Sparganium* and *Equisetum* sub-communities are more species-rich and of greater conservation interest.
S9	**Flood-plain fen**: base-poor and base-rich sump wetland	*Carex rostrata* sub-community: *Carex rostrata*: constant	The *Menyanthes-Equisetum* sub-community is more

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
	Open water transition fen **Valley fen**: base-poor and base-rich sump wetland	*Menyanthes trifoliata–Equisetum fluviatile* sub-community: *Carex rostrata*: <70% cover Associated species e.g. *Equisetum fluviatile, Menyanthes trifoliata, Potentilla palustris*: at least one species present, combined cover <30%	species-rich and of greater conservation interest.
S10	**Flood-plain fen**: base-poor sump wetland **Valley fen**: base-poor sump wetland	*Equisetum fluviatile* sub-community: *Equisetum fluviatile*: constant *Carex rostrata* sub-community: *Equisetum fluviatile*: forming an open stand, < 80% cover. Associated species e.g. *Carex rostrata, Menyanthes trifoliata, Potentilla palustris*: at least one species present, combined cover >20%	The *Carex* sub-community is more species-rich and of greater conservation interest. The associated species in the community may intermix and even dominate.
S11	**Open water transition fen**	*Carex vesicaria* sub-community: *Carex vesicaria*: constant *Veronica scutellata* sub-community: *Carex vesicaria*: <90% cover Associated species e.g. *Mentha aquatica, Myosotis scorpioides, Galium palustre, Veronica scutellata*: at least 3 species present *Carex rostrata* sub-community: *Carex vesicaria*: <90% cover Associated species e.g. *Mentha aquatica, Myosotis scorpioides, Galium palustre, Veronica scutellata, Carex rostrata, Potentilla palustris, Menyanthes trifoliata*: at least 2 species present forming a scattered understorey	The *Veronica* and *Carex rostrata* sub-communities are more species-rich and of greater conservation interest.
S12	**Flood-plain fen**: alluvial wetland **Open water transition fen**	*Typha latifolia* sub-community: *Typha latifolia*: constant Associated species e.g *Lemna minor, Solanum dulcamara, Aster tripolium:* at least one species present	The *Mentha* and *Alisma* sub-communities are more species-rich and of greater conservation interest. The

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
		Mentha aquatica sub-community: *Typha latifolia*: <90% cover Associated species e.g. *Mentha aquatica, Galium palustre, Juncus effusus*: combined cover >10% *Alisma plantago-aquatica* sub-community: *Typha latifolia*: <90% cover Associated species e.g. *Sparganium erectum, Eleocharis palustris, Alisma plantago-aquatica*: combined cover >10%	overall aim should be to produce an open sward of *Typha* not more than 1.5m tall, and with associated species. The sub-communities are likely to be zoned around open water.
S13	**Flood-plain fen**: base-rich sump wetland **Open water transition fen** **Valley fen**: base-rich sump wetland	*Typha angustifolia*: constant Associated species e.g. *Phragmites australis, Typha latifolia, Glyceria maxima*: at least one species present	This is an extremely species-poor community, usually forming rafts.
S14	**Flood-plain fen**: alluvial wetland **Open water transition fen**	*Sparganium erectum* sub-community: *Sparganium erectum*: constant *Alisma plantago-aquatica* sub-community: *Sparganium erectum*: constant Associated species e.g. *Alisma plantago-aquatica, Callitriche stagnalis, Rorippa nasturtium-aquaticum, Apium nodiflorum*: at least one species present *Mentha aquatica* sub-community: *Sparganium erectum*: constant Associated species e.g. *Mentha aquatica, Myosotis scorpioides, M. laxa, Juncus effusus, Carex otrubae*: at least 2 species present *Phalaris arundinacea* sub-community:	The *Alisma* and *Mentha* sub-communities are more species-rich and of greater conservation interest. The overall aim is to produce an open sward of *Sparganium*, <1m tall and with associated species. The sub-communities may be zoned around open water.

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
		Sparganium erectum: constant *Phalaris arundinacea* at least thinly distributed throughout	
S19	**Open water transition fen**	All sub-communities: *Eleocharis palustris* constant *Littorella uniflora* sub-community: *Littorella* at least occasional Associated spp. e.g. *Lobelia dortmanna, Equisetum fluviatile, Juncus bulbosus, Potamogeton natans,* present forming a scattered understorey *Agrostis stolonifera* sub-community: Associated spp. e.g. *Potentilla anserina* present as a low mat	The *Littorella* and *Agrostis* sub-communities are more species-rich and of greater conservation interest than the *Eleocharis palustris* sub-community.
S20	**Open water transition fen**	*Scirpus lacustris* ssp. *tabernaemontani* sub-community: *Schoenoplectus tabernaemontani*: constant *Agrostis stolonifera* sub-community: *Schoenoplectus tabernaemontani*: constant *Agrostis stolonifera* an open mat beneath *Schoenoplectus*	The *Agrostis* sub-community is more species-rich and of greater conservation interest.
S21	**Open water transition fen**	*Scirpus maritimus* sub-community: *Bolboschoenus maritimus*: constant *Atriplex prostrata* sub-community: *Atriplex prostrata*: constant, ground cover Associated saltmarsh species: at least one present, scattered *Agrostis stolonifera* sub-community: *Agrostis stolonifera*: constant, ground cover Associated saltmarsh species: at least one present, scattered *Potentilla anserina* sub-community: *Potentilla anserina* constant, scattered	The *Atriplex*, *Agrostis*, and *Potentilla* sub-communities are more species-rich and of greater conservation interest.

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
		Agrostis stolonifera: present, scattered	
S24	**Flood-plain fen**: base-rich alluvial and sump wetland **Open water transition fen** **Valley fen**: base-rich sump wetland	*Calamagrostis canescens, Cladium mariscus, Eupatorium cannabinum, Filipendula ulmaria, Galium palustre, Juncus subnodulosus, Lysimachia vulgaris, Mentha aquatica, Lythrum salicaria, Peucedanum palustre, Phragmites australis*: at least 5 species constant, one of which must be *Phragmites*, combined cover >80% *Carex paniculata* sub-community: *Carex paniculata*: tussocks present in stand *Calliergonella cuspidata, Brachythecium rutabulum, Lophocolea bidentata*: at least one species constant *Glyceria maxima* sub-community: *Glyceria maxima* prominent in stand *Symphytum officinale* sub-community: *Symphytum officinale, Iris pseudacorus, Lycopus europaeus, Angelica sylvestris, Cirsium palustre, Thalictrum flavum, Stachys palustris*: at least 4 species constant, one of which must be *Symphytum* *Cicuta virosa* sub-community: *Typha angustifolia, Sium latifolium, Berula erecta, Cicuta virosa*: at least one species constant *Schoenus nigricans* sub-community: *Schoenus nigricans, Carex elata, Juncus subnodulosus*: at least *Schoenus* constant *Myrica gale* sub-community: *Myrica gale, Cladium mariscus*: at least one species constant	The community is dependent on winter flooding and a high summer water table. The first target applies to all sub-communities, whilst further targets are additional to this.

NVC community	Relevant component wetland type(s)	Positive indicators (major, desirable and associated vascular plants and bryophytes)	Comments
S25	**Flood-plain fen**: alluvial wetland **Open water transition fen**	*Phragmites australis, Eupatorium cannabinum, Filipendula ulmaria, Angelica sylvestris, Juncus subnodulosus, Cirsium palustre, Mentha aquatica, Lythrum salicaria, Valeriana officinalis, Iris pseudacorus, Epilobium hirsutum*: at least 5 species constant, one of which must be *Phragmites australis*, combined cover >80% *Carex paniculata* sub-community: *Carex paniculata*: tussocks within the stand, frequently with seedings of *Salix cinerea* growing in the tops *Cladium mariscus* sub-community: *Cladium mariscus* prominent in stand	The community is dependent on winter flooding and a high summer water table, usually with base-rich waters. There is a moderate degree of nutrient enrichment. The first target applies to all sub-communities, whilst further targets are additional to this.
S27	**Flood-plain fen**: base-poor and base-rich sump wetland **Basin fen**: base-poor and base-rich sump wetland **Valley fen**: base-poor and base-rich sump wetland	EITHER *Carex rostrata, C. vesicaria, C. nigra, C. elata, C. aquatilis, C. appropinquata, Eriophorum angustifolium*: combined cover >25% OR *Phragmites australis, Juncus effusus*: combined cover >25% *Potentilla palustris, Menyanthes trifoliata, Equisetum fluviatile*: individually or together combined cover >25% *Calliergonella cuspidata, Calliergon cordifolium, C. giganteum*: at least one species at least rare Associated species *Galium palustre, Cardamine pratense, Epilobium palustre, Mentha aquatica, Myosotis laxa, Caltha palustris, Hydrocotyle vulgaris, Veronica scutellata, Lysimachia vulgaris*: at least 3 species constant	The balance between sedges and rushes and reeds is variable, changes from sedge domination to reed or rush may be undesirable on some sites. The bryophyte mat is sometimes extensive, other species may need to be substituted locally.

Table 6. Undesirable species for key NVC communities in lowland fens (see Table 4)

	Negative Indicators (non-woody species)																				Target for species marked as: (some NVC community types have individual targets for different habitat types)	
NVC Community	*Phragmites australis*	*Phalaris arundinacea*	*Glyceria maxima*	*Typha latifolia*	*Epilobium hirsutum*	*Urtica dioica*	*Pteridium aquilinum*	*Rubus fruticosus*	*Juncus spp*	*Brachythecium rutabulum*	*Eurhynchium praelongum*	*Molinia caerulea*	*Menyanthes trifoliata*	*Potentilla palustris*	*Equisetum fluviatile*	*Carex rostrata*	*Glyceria fluitans*	*Ulex europaeus*	*Galium aparine*	*Impatiens glandulifera*	X	O
M4, M5, M6 (see note)	X	X	X	X	X	X	O	O	X												Not more than one of the 'X' group of species and that <5% cover	Not more than one of the 'O' group of species and that <5% cover
M9	X	X	X		X	X	O	O		X	X	O										
M10, M13	X											O									No more than rare, <20 shoots in any sample	Cover <25%
M14	X	X	X		X	X	X	X		X	X	X									Not more than one species and that no more than rare and <5% cover	
M18 + sc*	O	X	X		X	X	X	X	X	X	X										Indicators of enrichment or of drying out: None of these should occur	Acceptable around upwellings or their equivalent on ditched bogs
M21	X	X	X		X	X	O	O		X	X	O									Not more than one of the 'X' group of species and that <5% cover	Not more than one of the 'O' group of species and that <5% cover
M22 + sc*, M25 + sc*	X	X	X		X	X	X	X		X	X										Singly or in combination <5% cover	
M27 + sc*, M28							X	X													<5% cover	
M29	X	X		X		X	X			X			X	X	X	X	X	X			Joint cover <5%	
S1																					Invasion of inter-tussock space by few large dominant species or >4 or 5 smaller ones	
S4 + sc*						X													X	X	No more than rare	

	Negative Indicators (non-woody species)																				Target for species marked as: (some NVC community types have individual targets for different habitat types)	
NVC Community	*Phragmites australis*	*Phalaris arundinacea*	*Glyceria maxima*	*Typha latifolia*	*Epilobium hirsutum*	*Urtica dioica*	*Pteridium aquilinum*	*Rubus fruticosus*	*Juncus spp*	*Brachythecium rutabulum*	*Eurhynchium praelongum*	*Molinia caerulea*	*Mesembryanthemum trifolliata*	*Potentilla palustris*	*Equisetum fluviatile*	*Carex rostrata*	*Glyceria fluitans*	*Ulex europaeus*	*Galium aparine*	*Impatiens glandulifera*	X	O
S9 sc*, S10 sc*, S19, S20 sc*	X	X	X	X																	No more than rare and <25% cover	
S12 sc*	X	X	X																		No more than rare and <25% cover	
S24 + sc*, S25 + sc*						X		X													<5% cover	
S27 (see note)	X	X	X		X	X	O	O				O									Not more than one of the 'X' group of species and that <5% cover	Not more than one of the 'O' group of species and that <5% cover

Note. For M6 sub-communities c and d, *Juncus acutiflorus* and/or *J. effusus* would not be appropriate negative indicators. Likewise for S27, *Phragmites* would not be appropriate as a negative indicator for some stands (usually S27b). See relevant targets and comments in Table 5.

APPENDIX 6

Ancient Woodland Indicators

Peterken and Game (1984)

Table 7. List of ancient woodland species in Cenral Lincolnshire, showing proportion of woodland localities in ancient woods.

Peterken (2000)

Table 1. Ancient woodland vascular plants in central Lincolnshire, showing the number of ancient and secondary woods in which each species was recorded in 1972-1981

Rose (1999)

Table 2. Ancient Woodland Vascular Plants in four regions of southern Britain

TABLE 7. List of ancient woodland species in central Lincolnshire, showing proportion of woodland localities in ancient woods.

Species	Woodland localities (of 362)	Proportion of localities in ancient woods (%)
Agropyron caninum	28	64
Ajuga reptans	143	54
Allium ursinum	40	65
Anemone nemorosa	95	85
Betonica officinalis	49	65
Calamagrostis canescens	43	84
C. epigejos	70	60
Campanula latifolia	42	50
Carex acutiformis	59	66
C. pallescens	28	96
C. pendula	9	100
C. remota	66	82
C. sylvatica	115	64
Conopodium majus	67	69
Convallaria majalis	41	80
Dactylorchis fuchsii	35	69
Digitalis purpurea	24	54
Dipsacus pilosus	10	90
Endymion non-scriptus	127	61
Epilobium obscurum	12	75
Eupatorium cannabinum	14	64
Fragaria vesca	69	65
Galeobdolon luteum	46	83
Galium odoratum	29	97
Geum rivale	101	67
Humulus lupulus	10	60
Hypericum hirsutum	79	63
H. humifusum	14	64
H. perforatum	15	53
H. pulchrum	26	54
H. tetrapterum	43	58

TABLE 7—*continued*

Species	Woodland localities (of 362)	Proportion of localities in ancient woods (%)
Juncus acutiflorus	26	54
Luzula pilosa	57	86
L. sylvatica	14	93
Lychnis flos-cuculi	56	79
Lysimachia nemorum	22	91
L. vulgaris	15	93
Melampyrum pratense	13	100
Melica uniflora	41	88
Mentha aquatica	31	52
Mercurialis perennis	116	54
Milium effusum	30	97
Neottia nidus-avis	10	100
Orchis mascula	68	76
Oxalis acetosella	43	88
Paris quadrifolia	9	100
Pimpinella major	42	55
Platanthera chlorantha	32	94
Poa nemoralis	14	79
Potentilla sterilis	76	82
Primula vulgaris	102	74
Ranunculus auricomus	43	74
Rubus caesius	91	54
Sanicula europaea	28	57
Scrophularia nodosa	83	72
Stellaria holostea	120	58
Succisa pratensis	43	63
Valeriana officinalis	53	77
Veronica montana	16	75
V. officinalis	59	58
Vicia sepium	15	80
Viola reichenbachiana	23	74

Table 1 Ancient woodland indicator vascular plants in central Lincolnshire, showing the number of ancient and secondary woods in which each species was recorded in 1972-1981.

		Frequency in ancient woods No. ex 89	Frequency in secondary woods No. ex 273	Proportion in ancient woods %
Melampyrum pratense	Common Cow-wheat	14	0	100
Neottia nidus-avis	Bird's-nest Orchid	10	0	100
Carex pendula	Pendulous Sedge	9	0	100
Paris quadrifolia	Herb-Paris	9	0	100
Carex strigosa	Thin-spiked Wood-sedge	6	0	100
Lathyrus linifolius	Bitter-vetch	5	0	100
Chrysosplenium alternifolium	Alternate-leaved Golden-saxifrage	4	0	100
Equisetum sylvaticum	Wood Horsetail	3	0	100
Vicia sylvatica	Wood Vetch	3	0	100
Aquilegia vulgaris	Columbine	1	0	100
Carex laevigata	Smooth-stalked Sedge	1	0	100
Lathraea squamaria	Toothwort	1	0	100
Maianthemum bifolium	May Lily	1	0	100
Sedum telephium	Orpine	1	0	100
Stellaria nemorum	Wood Stitchwort	1	0	100
Carex pallescens	Pale Sedge	28	1	97
Platanthera chlorantha	Greater Butterfly-orchid	31	2	94
Lysimachia vulgaris	Yellow Loosestrife	15	1	94
Galium odoratum	Sweet Woodruff	29	2	94
Luzula sylvatica	Great Wood-rush	13	1	93
Milium effusum	Wood Millet	30	3	91
Lysimachia nemorum	Yellow Pimpernel	20	2	91
Melica uniflora	Wood Melick	36	4	90
Dipsacus pilosus	Small Teasel	9	1	90
Luzula pilosa	Hairy Wood-rush	50	8	86
Sorbus torminalis	Wild Service-tree	31	5	86
Oxalis acetosella	Wood-sorrel	37	6	86
Calamagrostis canescens	Purple Small-reed	36	6	86
Anemone nemorosa	Wood Anemone	81	14	85
Tilia cordata	Small-leaved Lime	63	11	85
Campanula trachelium	Nettle-leaved Bellflower	5	1	83
Euonymus europeaus	Spindle	34	7	83
Lamiastrum galeobdolon	Yellow Archangel	38	8	83
Carex remota	Remote Sedge	54	12	82
Potentilla sterilis	Barren Strawberry	62	14	82
Orchis mascula	Early-purple Orchid	53	12	82
Epipactis helleborine	Broad-leaved Helleborine	4	1	80
Convallaria majalis	Lily-of-the-valley	31	8	79
Lychnis flos-cuculi	Ragged Robin	44	12	79
Valeriana dioica	Marsh Valerian	7	2	78
Viola reichenbachiana	Early Dog-violet	19	6	76
Primula vulgaris	Primrose	84	28	75
Valeriana officinalis	Common Valerian	42	14	75
Ranunculus auricomus	Goldilocks Buttercup	27	9	75
Poa nemoralis	Wood Meadow-grass	12	4	75
Epilobium obscurum	Short-fruited Willowherb	9	3	75
Scrophularia nodosa	Common Figwort	68	26	72
Quercus petraea	Sessile Oak	13	5	72
Hypericum hirsutum	Hairy St John's-wort	57	23	71
Veronica montana	Wood Speedwell	12	5	71
Populus tremula	Aspen	55	23	71
Dactylorhiza fuchsii	Common Spotted-orchid	26	11	70
Conopodium majus	Pignut	46	20	70
Lysimachia nummularia	Creeping-jenny	25	11	69
Eupatorium cannabinum	Hemp-agrimony	9	4	69
Hypericum humifusum	Trailing St John's-wort	9	4	69
Cornus sanguinea	Dogwood	65	30	68
Allium ursinum	Ramsons	27	13	68
Carex acutiformis	Lesser Pond-sedge	39	19	67
Fragaria vesca	Wild Strawberry	46	23	67
Geum rivale	Water Avens	68	35	66
Stachys officinalis	Betony	31	16	66
Carex sylvatica	Wood-sedge	74	39	65
Frangula alnus	Alder Buckthorn	12	7	63
Hyacinthoides non-scripta	Bluebell	77	50	61
Viburnum opulus	Guelder-rose	61	40	60
Elymus caninus	Bearded Couch	15	10	60
Humulus lupulus	Hop	6	4	60
Chrysosplenium oppositifolium	Opposite-leaved Golden-saxifrage	3	2	60
Ophioglossum vulgatum	Adder's-tongue	3	2	60
Veronica officinalis	Heath Speedwell	35	24	59
Stellaria holostea	Greater Stitchwort	76	54	58
Prunus avium	Wild Cherry	16	12	57
Hypericum tetrapterum	Square-stalked St John's-wort	25	19	57
Hypericum pulchrum	Slender St John's-wort	15	12	56
Sanicula europaea	Sanicle	15	12	56
Corylus avellana	Hazel	86	70	55
Adoxa moschatellina	Moschatel	17	14	55
Mercurialis perennis	Dog's Mercury	62	53	54
Campanula latifolia	Giant Bellflower	19	17	53

Wood-rush *Luzula pilosa* (50, 8) and Small-leaved Lime *Tilia cordata* (63, 11). Thus, even Wood Anemone would have misled in 22 of the 362 woods, and other species would have misled even more frequently. If we take several such species together, we would 'identify' more ancient woods, but also incorrectly 'identify' more secondary woods as ancient, i.e. there would be a loss of precision.

Whatever approach we try, we are forced to conclude that, whilst individual species might in theory be used to identify some woods as ancient, they cannot be used to prove by their absence that any wood is secondary: even the most exacting species may colonise occasionally. Indicators can be much more reliable collectively, but they are unlikely to identify all woods that are in fact ancient. If we count the number present from a group of indicators, not only do we need standards to decide how many is enough to show ancient status, but we may also lose precision in the identifications.

Ancient woodland indicators in central Lincolnshire

Ecologists have, of course, long recognised that it is better to use species collectively. In the Nature Conservancy Council we were counting the species from lists of indicators as a quick indication of the status of a wood from 1973 onwards (e.g. Peterken 1974), and the concept

Table 2 Ancient Woodland Vascular Plants in four regions of southern Britain. **SW** = south-west England (Cornwall, Devon, Somerset, Avon and Dorset); **S** = central-southern England (NCC 'South Region' – Hampshire, Wiltshire, Buckinghamshire, Berkshire and Oxfordshire); **SE** = south-east England (Kent, Surrey, Sussex, London and Hertfordshire); **EA** = East Anglia (Essex, Suffolk, Norfolk, Cambridgeshire).

Scientific name	Common name	SW	S	SE	EA
*Acer campestre**	Field Maple	■	■	■	■
Aconitum napellus	Monk's-hood	■			
Adoxa moschatellina	Moschatel	■	■	■	■
Allium ursinum	Ramsons	■	■	■	■
Anagallis minima	Chaffweed			■	
Anemone nemorosa	Wood Anemone	■	■	■	■
*Aquilegia vulgaris**	Columbine	■	■	■	
Blechnum spicant	Hard Fern	■	■	■	■
Bromopsis ramosa	Hairy-brome	■	■	■	■
Calamagrostis canescens	Purple Small-reed				■
Calamagrostis epigejos	Wood Small-reed	■	■	■	■
Campanula latifolia	Giant Bellflower				■
Campanula trachelium	Nettle-leaved Bellflower	■	■	■	■
Cardamine amara	Large Bitter-cress		■	■	■
Carex laevigata	Smooth-stalked Sedge	■	■	■	
Carex pallescens	Pale Sedge	■	■	■	■
*Carex pendula**	Pendulous Sedge	■	■	■	■
Carex remota	Remote Sedge	■	■	■	■
Carex strigosa	Thin-spiked Wood-sedge	■	■	■	■
Carex sylvatica	Wood-sedge	■	■	■	■
*Carpinus betulus**	Hornbeam		■	■	■
Cephalanthera longifolia	Sword-leaved Helleborine		■		
Ceratocapnos claviculata	Climbing Corydalis	■	■		■
Chrysosplenium alternifolium	Alternate-leaved Golden-saxifrage				■
Chrysosplenium oppositifolium	Opposite-leaved Golden-saxifrage	■	■	■	■
Colchicum autumnale	Meadow Saffron	■	■		
Conopodium majus	Pignut	■	■	■	■
*Convallaria majalis**	Lily-of-the-valley	■	■	■	■
Crataegus laevigata	Midland Hawthorn		■	■	■
*Daphne laureola**	Spurge-laurel	■	■	■	■
Dipsacus pilosus	Small Teasel	■	■	■	■
Dryopteris aemula	Hay-scented Buckler-fern	■		■	
Dryopteris affinis	Scaly Male-fern	■	■	■	■
Dryopteris carthusiana	Narrow Buckler-fern	■	■	■	■
Elymus caninus	Bearded Couch	■	■	■	■
Epipactis helleborine	Broad-leaved Helleborine	■	■	■	■
Epipactis leptochila	Narrow-lipped Helleborine		■		
Epipactis purpurata	Violet Helleborine		■	■	■
Equisetum sylvaticum	Wood Horsetail	■	■	■	■
Euonymus europaeus	Spindle	■			■
Euphorbia amygdaloides	Wood Spurge	■	■	■	■
Festuca gigantea	Giant Fescue	■	■	■	■
Frangula alnus	Alder Buckthorn	■	■	■	■
Gagea lutea	Yellow Star-of-Bethlehem				■
Galium odoratum	Sweet Woodruff	■	■	■	■
Geum rivale	Water Avens	■	■		■
Gnaphalium sylvaticum	Heath Cudweed				■
*Helleborus viridis**	Green Hellebore	■	■	■	■
Holcus mollis	Creeping Soft-grass	■	■	■	
Hordelymus europaeus	Wood Barley		■		
Hyacinthoides non-scripta	Bluebell	■	■	■	■
Hymenophyllum tunbrigense	Tunbridge Filmy-fern	■			
Hypericum androsaemum	Tutsan	■	■	■	■
Hypericum pulchrum	Slender St John's-wort	■	■	■	■
Ilex aquifolium	Holly	■	■	■	■
Iris foetidissima	Stinking Iris	■	■	■	■
Lamiastrum galeobdolon	Yellow Archangel	■	■	■	■
Lathraea squamaria	Toothwort	■	■	■	■
Lathyrus linifolius	Bitter-vetch	■	■	■	■ (Ex only)
Lathyrus sylvestris	Narrow-leaved Everlasting-pea	■	■	■	
Luzula forsteri	Southern Wood-rush	■	■	■	
Luzula pilosa	Hairy Wood-rush	■	■	■	■
Luzula sylvatica	Great Wood-rush	■	■	■	■

Lysimachia nemorum	Yellow Pimpernel	■	■	■	■
Maianthemum bifolium	May Lily				■ (Nf only)
*Malus sylvestris**	Crab Apple	■	■	■	■
Melampyrum cristatum	Crested Cow-wheat				■
Melampyrum pratense	Common Cow-wheat	■	■	■	■
Melica uniflora	Wood Melick	■	■	■	■
Melittis melissophyllum	Bastard Balm	■			
Milium effusum	Wood Millet	■	■	■	■
Moehringia trinervia	Three-veined Sandwort	■	■	■	■
*Myosotis sylvatica**	Wood Forget-me-not			■	■
*Narcissus pseudonarcissus**	Wild Daffodil	■	■	■	■
Neottia nidus-avis	Bird's-nest Orchid	■	■	■	■
Ophrys insectifera	Fly Orchid				■
Orchis mascula	Early Purple Orchid	■	■	■	■
Orchis purpurea	Lady Orchid			■	
Oreopteris limbosperma	Lemon-scented Fern	■	■	■	■
Oxalis acetosella	Wood-sorrel	■	■	■	■
Paris quadrifolia	Herb-Paris	■	■	■	■
Phegopteris connectilis	Beech Fern	■			
*Phyllitis scolopendrium**	Hart's-tongue	■	■	■	■
Pimpinella major	Greater Burnet-saxifrage			■	■
Platanthera chlorantha	Greater Butterfly-orchid	■	■	■	■
Poa nemoralis	Wood Meadow-grass	■	■	■	■
Polygonatum multiflorum	Solomon's-seal	■	■	■	
Polypodium vulgare (sensu lato)	Polypody (all species)	■	■	■	■
Polystichum aculeatum	Hard Shield-fern	■	■	■	■
Polystichum setiferum	Soft Shield-fern	■	■	■	■
Populus tremula	Aspen	■	■	■	■
Potentilla sterilis	Barren Strawberry	■	■	■	■
Primula elatior	Oxlip				■
*Primula vulgaris**	Primrose	■	■	■	■
Prunus avium	Wild Cherry	■	■	■	■
Prunus padus	Bird Cherry				■
Pulmonaria longifolia	Narrow-leaved Lungwort	■	■		
Pulmonaria obscura†	Suffolk Lungwort				■ (Sf only)
*Quercus petraea**	Sessile Oak	■	■	■	■
Radiola linoides	Allseed			■	
Ranunculus auricomus	Goldilocks Buttercup	■	■	■	■
*Ribes nigrum**	Black Currant		■	■	■
*Ribes rubrum**	Red Currant	■	■	■	■
Rosa arvensis	Field-rose	■	■	■	
Ruscus aculeatus	Butcher's Broom	■	■	■	■
Sanicula europaea	Sanicle	■	■	■	■
Scirpus sylvaticus	Wood Club-rush	■	■	■	
Scutellaria minor	Lesser Skullcap			■	
Sedum telephium	Orpine	■	■	■	■
Serratula tinctoria	Saw-wort		■	■	
Sibthorpia europaea	Cornish Moneywort	■			
Solidago virgaurea	Golden-rod	■	■	■	
Sorbus (microspecies)	whitebeam (microspecies)	■			
Sorbus aucuparia	Rowan				■
Sorbus torminalis	Wild Service Tree	■	■	■	■
Stachys officinalis	Betony	■	■	■	■
Stellaria neglecta	Greater Chickweed				■
Tamus communis	Black Bryony	■	■	■	■
*Tilia cordata**	Small-leaved Lime	■	■	■	■
Ulmus glabra	Wych Elm	■	■	■	■
Vaccinium myrtillus	Bilberry	■	■	■	
Veronica montana	Wood Speedwell	■	■	■	■
Viburnum lantana	Wayfaring-tree				■
*Viburnum opulus**	Guelder Rose	■	■	■	■
Vicia sepium	Bush Vetch	■	■	■	■
Vicia sylvatica	Wood Vetch	■	■	■	
Viloa odorata	Sweet Violet				■
Viola palustris	Marsh Violet	■	■	■	
Viola reichenbachiana	Early Dog-violet	■	■	■	■
Wahlenbergia hederacea	Ivy-leaved Bellflower	■		■	

*Consider these species only if they occur well within the wood and do not appear to have been planted. † Found in only a small area at present but may have been overlooked.

APPENDIX 7

Rivers and Wetlands

Holmes (1989)

Figure 3. Examples of species from the four main groups

Environment Agency (1997)

Emergent Plants

Aquatic Plants

Figure 3 Examples of species from the four main groups

EMERGENT PLANTS

Acorus calamus
Alisma plantago-aquatica
Alopecurus geniculatus
Althaea officinalis
Anagallis tenella
Angelica sylvestris
Apium inundatum
Apium nodiflorum
Aster tripolium
Atriplex glabriuscula
Atriplex lacinata
Atriplex littaralis
Baldellia raunculoides
Barbarea vulgaris
Berula erecta
Bidens cernua
Bidens tripartita
Butomus umbellatus
Cakile martima
Caltha palustris
Cardamine amara
Cadamine pratensis
Carex acuta
Carex acutiformis
Carex disticha
Carex flacca
Carex strubae
Carex panicea
Carex paniculata
Carex pseudocyperus
Carex riparia
Carex rostrata
Carex vesicaria
Catabrosa aquatica
Chrysosplenium oppositifolium
Chrysosplenium alternifolium
Cochlearia anglica
Cochlearia danica
Cochlearia officinalis
Crithmum maritimum
Eleocharis acicularis
Eleocharis palustris
Equisetum fluvitale
Equisetum hyemale
Equisetum palustre
Equisetum telmateia
Eriophorum angustifolium
Eupatorum cannabinum
Galium palustre
Galium uliginosum
Geum rivale
Glaux maritima
Glyceria declinata
Glyceria fluitans
Glyceria plicata
Halimione portulacoides
Heracleum mantegazzianum
Hippuris vulgaris
Hydrocotyle vulgaris
Hypericum ilodes
Impatiens capensis
Impatiens glandulifera
Iris pseudacorus
Juncus (all)
Lotus uliginosus
Lychnis flos-cuculi
Lycopus europaeus
Lysimachia vulgaris
Lythrum salicaria
Mentha aquatica
Menyanthes trifoliata
Mimulus guttatus
Mimulus luteus
Mimulus moschatus
Myosotis scorpioides
Mysoton squaticum
Nasturtium microphyllum
Nasturtium officinale
Nasturtium x sterile
Oenanthe aquatica
Oenanthe crocata
Oenanthe fistulosa
Oenanthe lachenalii
Oenanthe pimpinelloides
Oenanthe silaifolia
Parnassia palustris
Phalaris arundinacea
Phragmites australis
Pilulifera globulifera
Plantago maritima
Polygonum amphibium
Polygonum hydropiper

EMERGENT PLANTS [Continued …….]

Potentiall palustris
Ranunculus flammula
Ranunculus lingua
Ranunculus sceleratus
Rorippa amphibia
Rumex hydrolapathum
Sagittaria sagittifolia
Salicornia (all)
Salsola kali
Schoenoplectus lacustris
Schoenoplectus pungens
Schoenoplectus tabernaemontani
Schoenoplectus triquetus
Scrophularia auriculata
Scutellaria galericulata

Glyceria maxima
Glyceria plicata
Solanum dulcamara
Sonchus palustris
Sparganium erectum
Spartina (all)
Spergularia marina
Spergularia media
Stachys palustris
Stellaria alsine
Suaeda maritima
Thalictrum flavum
Triglochin maritima
Tripleurospernum maritimum
Typha angustifolia
Typha latifolia
Valeriana dioica
Valeriana officinalis
Veronica anagallis-aquatica
Veronica beccabunga
Veronica catenata
Senecio aquaticus
Sium latifolia

Emergent species were defined as those growing along the water's edge or occurring within the aquatic zone and having for most of the summer the majority of their biomass above the water surface.

AQUATIC PLANTS

Azolla filiculodies
Callitriche agg.
Ceratophyllum demersum
Ceratophyllum submersum
Chaura agg.
Crassula aquatica
Crassula helmsii
Elodea canadensis
Elodea nuttallii
Groenlandia densa
Hottonia palusris
Hydrocharis morsus-ranae
Lemna gibba
Lemna minor
Lemna mimiscula
Lemna polyrhiza
Lemna trisulca
Myriophyllum alterniflorum
Myriophyllum spicatum
Myriophyllum verticillatum
Nymphaea alba
Mymphoides peltata
Oenanthe fluviatilis
Potamogeton (all)
Ranunculus aquatilis
Ranunculus baudotii
Ranunculus circinatus
Ranunculus fluitans
Ranunculus hederaceus
Ranunculus peltatus
Ranunculus penicillatus
Ranunculus tripartitus
Sparganium emersum
Stratiotes aloides
Utricularia australis
Utricularia intermedia
Utricularia minor
Utricularia vulgaris
Wolffia arrhiza
Zannichellia palustris

Aquatic species were defined as being those species that are wholly submerged, free-floating, rooted by floating-leaved, and those species that for most of the summer have the bulk of their biomass below the water surface.

APPENDIX 8

Saltmarsh

Tabor (2003)

Table 1. Saltmarsh zones and their typical flora in eastern England

Table 1 Saltmarsh zones and their typical flora in eastern England.
Note that the species and zones described are indicators, and the exact composition of the communities in each zone will vary from marsh to marsh.

Zone	Typical plants	Approximate tidal inundations per annum
Pioneer	Sea Lettuce *Ulva lactuca*; eel-grasses *Zostera*	700
Lower marsh	glassworts *Salicornia*; Annual Sea-blite *Suaeda maritima*; cord-grasses *Spartina*; Sea Aster *Aster tripolium*	<600
Middle marsh	Common Saltmarsh-grass *Puccinellia maritima*; Sea-purslane *Atriplex portulacoides*; Sea-lavender *Limonium vulgare*; Sea Plantain *Plantago maritima*; Thrift *Armeria maritima*; Greater Sea-spurrey *Spergularia media*	<450
Upper marsh	Sea Rush *Juncus maritimus*; Saltmarsh Rush *Juncus gerardii*; Golden-samphire *Inula crithmoides*; Shrubby Sea-blite *Suaeda vera*; Sea Wormwood *Seriphidium maritimum*; Red Fescue *Festuca rubra*; Sea-milkwort *Glaux maritima*; Sea Couch *Elytrigia atherica*	<300
Transition to terrestrial/fresh-water marsh	Common Reed *Phragmites australis*; Parsley Water-dropwort *Oenanthe lachenalii*; Canary-grass *Phalaris arundinacea*; bents *Agrostis*	Nil

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